Mycorrhiza

Issues relevant to roadside revegetation

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16 Abstract

Caltrans Division of Design contracted a targeted review of the available literature regarding mycorrhiza to ascertain positive or negative affects on revegetation from the addition of local or non-local mycorrhizal fungal inocula, and whether a compelling case exists now for the routine addition of commercially available mycorrhizal fungi spores as part of any Standard Specification for roadside revegetation projects conducted by Caltrans.

Soil disturbance, such as construction site excavation or mine spoils, results in the alteration of major physicochemical and biological soil properties including soil structure, plant nutrient availability, organic matter content, and microbial activities. Natural repopulation of altered soil by mycorrhizal fungal spores can occur by means of several vectors, including animals and wind. However, when re-establishment of target vegetation is urgent, or has become problematic, site amendment with mycorrhizal propagules has been practiced.

A 2011 internet search for this review found 25 companies worldwide marketing 30 products containing mycorrhizal fungal inocula. Taxonomic diversity in these inoculant products is low at 28 species total. Only eight (27%) of the 30 products provide any geographic origin for the mycorrhizal species used. The generally unspecified origins in commercial inocula may reflect the relatively few collections from wild sources now cultured by commercial labs capable of large-scale production. A 2011 internet search of metadata avail-able from the two primary culture repositories revealed that they hold few accessions from California, and that many of the commonly used *Glomus* species accessions are from eastern North America, Central America, South America, and Europe. If the origins of commercial inocula trace to these accessions, then nearly all of these products contain AMF genotypes alien to California. The intentional use, culture, and dispersal of mycorrhizal fungal species hold potential for unintended negative consequences similar to those that accompany any introduction of extralimital plant or animal species.

With ecological studies documenting potential serious negative consequences of inoculation, research results are needed that elucidate the best management practice for mycorrhizal treatments before statewide specifications can be written and enacted. Until then, the following strategy is recommended:

Best Management Practices

–Where Local Topsoil is Available

Balance pros and cons of soil transfer or stockpiling (SSP 20-170 Local Topsoil) as a means to reapply local mycorrhizal fungi and native plant propagules.

–Where Local Topsoil is Not Available

Design adequate physical erosion control using SSP 20-055 Compost Blanket, SSP 20-356 Jute Mesh, and SSP 20-060 Fiber Rolls.

Specify native pioneer species known to be nonmycorrhizal, or facultatively mycorrhizal with generalist AMF or EMF.

Potential Policies

–Favor the use of local fungal genotypes for inoculum.

–Promote development of commercial inoculum standards.

The many different kinds of formulated products available commercially implore need for established standards and quality control. Commercial products should provide physical and chemical properties of the inoculum: pH, nutrient carriers, and additives; AM fungal propagule density using standardized techniques; effectiveness of the inoculum based on examples where the relevant inoculum was used successfully under similar ecological conditions; certification that the inoculum is pathogen-free; inoculum storage information with recommended dates of usage and the maximum dilution of the content; and presence/ absence of transgenic elements (transformed roots) used in production of the inoculum.

17 Key Words **mycorrhiza, ectomycorrhiza, arbuscular mycorrhiza, inoculum, revegetation, highway planting, alien species,**		18 Distribution Statement **No restrictions. This document is available to the public through the California Department of Transportation**	
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Mycorrhizal symbioses are ubiquitous structural and functional interactions involving soil fungi (*mycor*) and vascular plant roots (*rhiza*) of most terrestrial ecosystems. There are two primary groups, arbuscular mycorrhizal fungi (AMF) and ectomycorrhizal fungi (EMF) based on the differences in the morphology of their root associations. Most mycorrhizal fungal associations are mutualistic with various benefits conferred to the host plant by modifying root functions and selectively influencing rhizosphere microbial populations. Symbiotic mycorrhizal fungi are essential components of sustainable soil-plant systems, with the mycelial network external to plant roots often constituting 20%–30% of the total soil microbial biomass.

Soil disturbance, such as construction site excavation or mine spoils, results in the alteration of major physico-chemical and biological soil properties including soil structure, plant nutrient availability, organic matter content, and microbial activities. Severely altered soils lack a viable population of mycorrhizal fungi. Even salvaged and re-applied topsoil, a routine practice in land rehabilitation, suffers some degradational effects with decreases in mycorrhizal populations and reduced growth of arbuscular mycorrhizal fungi, along with dramatic shifts in the microbial community structure, and general declines in soil quality and nutrient cycling capacity. Natural repopulation of altered soil by mycorrhizal fungal spores can occur by means of several vectors, including animals and wind. However, when re-establishment of target vegetation is urgent, or has become problematic, site amendment with mycorrhizal propagules has been practiced.

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Preface

Task Objective

At the request of Caltrans Division of Design, the Roadside Erosion Control and Management Study team conducted a targeted review of the available literature regarding mycorrhiza to ascertain:

1. positive or negative affects on revegetation from the addition of local or non-local mycorrhizal fungal inocula, and

2. whether a compelling case exists now for the routine addition of commercially available mycorrhizal fungi spores as part of any Standard Specification for roadside revegetation projects conducted by Caltrans.

Tasks

1 Devise a list of search terms pertaining to mycorrhiza.

Primary search terms used alone or in Boolean sets were:

mycorrhiza	colonizer	assay
arbuscular fungi	host specificity	inventory
arbuscular mycorrhiza	inoculum	application
AM fungi	in vitro	production
ectomycorrhiza	horticulture	purity
EM fungi		
soil microflora	nutrient aquisition	alien
soil types	nitrogen	native
edaphic	phosphorus	California
serpentine	water uptake	genetic contamination
stockpiled topsoil		genetic diversity
		invasion
plant communities	restoration	
community	revegetation	
forest	succession	
woodland	vegetation	
shrubland	roadside	
grassland		

Preface

Tasks

2

Conduct a targeted review of online and hardcopy journal articles, books, government documents, dissertations, theses, and other references.

The general literature on mycorrhiza is immense. Over 300 articles were read for this review; 286 references are cited throughout the body and listed in **Section 7**.

Primary literature was obtained largely from these journals:

Advances in Botanical Research
Agriculture, Ecosystems & Environment
American Journal of Botany
Annals of Botany
Annual Review of Ecology Evolution and Systematics
Annual Review of Phytopathology
Applied and Environmental Microbiology
Applied Soil Ecology
Australian Journal of Agricultural Research
Australian Journal of Botany
Biological Invasions
Biological Reviews of the Cambridge Philosophical Society
Bioresource Technology
Biotropica
Botanical Review
Canadian Journal of Botany
Canadian Journal of Forest Research
Canadian Journal of Microbiology
Ecological Economics
Ecology
Ecology Letters
Empire Forestry Journal
Environmental and Experimental Botany
Environmental Pollution
FEMS Microbiology Ecology
Forest Ecology and Management
Forest Science
Frontiers in Ecology and the Environment
Functional Ecology
Hortscience
Journal of Applied Ecology
Journal of Ecology
Journal of Forestry
Land Degradation and Development
Molecular Ecology
Mycologia
Mycological Research
Mycorrhiza
Native Plants Journal
Nature
New Phytologist
Oecologia
Physiologia Plantarum
Plant and Soil
Plant Cell and Environment
Restoration Ecology
Revue Forestière Française
Science
Scientia Horticulturae
Soil Biology and Biochemistry
Transactions of the British Mycological Society
Trends in Ecology & Evolution

3

Write a synopsis of current thinking on the effects and consequences from addition of mycorrhizal fungal spores to roadside revegetation sites.

1 Definition and Benefits

1.1 Mycorrhizal symbiosis

Mycorrhizal symbioses are ubiquitous structural and functional interactions involving soil fungi (Gk: *mykes* > L: *mycor*) and vascular plant roots (Gk: *rhiza*) of most terrestrial ecosystems (Pringle et al 2009). Nearly 95% of the world's plant species belong to families that are characteristically mycorrhizal, and although the mycorrhizal status of most species has not been probed explicitly, an estimated 80% of surveyed land plant species are mycorrhizal (Smith et Read 2008; Trappe 1987; Wang et Qiu 2006). See **Appendix A** for mycorrhizal occurrence among land plant taxa.

1.2 Practical uses and applications

The intentional use of mycorrhizal fungi has been pursued owing to the promise of harnessing beneficial soil organisms for improved agriculture (Gianinazzi et al 2002), horticulture (Azcon-Aguilar et Barea 1997), habitat restoration (Miller et Jastrow 1992), bioremediation (Leyval et al 2002), and forestry (Brundrett et al 1996, Duponnois et al 2005).

Most mycorrhizal fungal associations are considered mutualistic with various benefits conferred to the host plant by modifying root functions and selectively influencing rhizosphere microbial populations (Andrade et al 1998). Benefits to host plants include:

- improved drought tolerance (Augé 2001);
- enhanced nutrient uptake (especially phosphorus and nitrogen, but also magnesium, zinc, copper, and iron) (Jones et Smith 2004);
- proportional dependence of legumes on atmospheric nitrogen (Chalk et al 2006);
- resistance to soil pathogens (Bororwicz 2001);
- tolerance to environmental extremes (Marx et Krupa 1978);
- yield and survival of desirable plant species (Bethlenfalvay et Linderman 1992);
- reductions in fitness of noxious invasive weeds (Johnson 1998);
- and decreased uptake of toxic compounds (Rufyikiri et al 2004).

Note

In this review, the term *mycorrhiza*, devised by Frank 1885, is used as both a singular and plural noun, as with deer, sheep, or salmon. The poorly formed plural nouns *mycorrhizae* and *mycorrhizas* may be seen elsewhere.

1 Definition and Benefits

Symbiotic mycorrhizal fungi are considered essential components of sustainable soil-plant systems (Schreiner et al 2003), with the mycelial network external to plant roots often constituting 20%–30% of the total soil microbial biomass (Leake et al 2004). Benefits conferred to the rhizosphere include soil aggregation and stability (Miller et Jastrow 2000) and soil carbon storage (Hogberg et Hogberg 2002). In natural ecosystems mycorrhiza mediate carbon flow and nutrient cycling (Perry et al 1987; Kropp et Langlois 1990; Vogt et al 1991). Exercising a fundamental role in the organization of terrestrial ecosystems (Hart et al 2001), they are thought to influence or regulate plant species community composition (Allen et al 1995; Klironomos 2003) and patterns of plant succession (Allen et Allen 1988).

The symbioses also influence structure and function of the surrounding bacterial communities (Marshner et al 2001; Marshner et Timonen 2005) in a microbial compartment known as the “mycorrhizosphere” (Linderman 1988). Organic compounds produced by external mycelia provide microsites for microbial colonization and growth (Johansson et al 2004); the soil around fungal hyphae (the hyphosphere) supports different bacterial activities and community composition from those of the mycorrhizosphere (Andrade et al 1998; Mansfield-Giese et al 2002; Marshner et Timonen 2005). It follows that microorganisms in the hyphosphere may affect the functions of the external fungal mycelia, such as nutrient and water transport from the soil to the host plant (Bethlenfalvay et al 1999; Mansfield-Giese et al 2002).

1.3 Soil disturbance and mycorrhiza

Soil disturbance, such as construction site excavation or mine spoils, results in the alteration of major physicochemical and biological soil properties including soil structure, plant nutrient availability, organic matter content, and microbial activities (Pieri 1991). Severely altered soils lack a viable population of mycorrhizal fungi (Moorman et Reeves 1979; Jasper et al 1989). Even salvaged and re-applied topsoil, a routine practice in land rehabilitation, suffers some degradational effects with decreases in mycorrhizal populations (Rives et al 1980; Gould et Liberta 1981; Miller et al 1985), reduced growth of arbuscular mycorrhizal fungi (Visser et al 1984b), dramatic shifts in the microbial community structure (Visser et al 1984a), and general declines in soil quality and nutrient cycling capacity (Vogelsang et Bever 2009).

Natural repopulation of altered soil by mycorrhizal fungal spores can occur by means of several vectors, including animals and wind (Marx 1975; Moser et al 1978; MacMahon et Warner 1984; Allen 1987; Warner et al 1987). However, when re-establishment of target vegetation is urgent or has become problematic, site amendment with mycorrhizal

propagules has been practiced. The potential benefits of introducing arbuscular mycorrhizal fungi for revegetation purposes, where the soil integrity has been degraded and mycorrhiza are lacking (Salyards et al 2003), have been identified as:

- improved survivorship and increased growth of target plants (Williams et al 1974; Aldon 1975; Daft et Hacskaylo 1977; Estaún et al 1997; Smith et al 1998; Duponnois et al 2001; Walker et al 2004);
- increased seedling establishment under conditions of nutrient and water stress (Read et al 1976);
- facilitating establishment of native plants by mitigating the loss of mycorrhizal fungal density (Vogelsang et Bever 2009);
- fostering native plant community successional processes from non-mycorrhizal annuals to mycorrhizal perennials (Reeves et al 1979; Janos 1980; Wilson et Hartnett 1998; Smith et al 1988; St. John et Evans 1990) and accelerating succession by recolonizing plants (Allen et Allen 1988; Miller et Jastrow 1992);
- improved sediment control with greater stabilization of soil aggregates by mycorrhizal hyphae (Vogelsang et Bever 2010) which form a hyphal network in and/or around plant roots that extends far into the surrounding substrate (Antolin 2008);
- improved physical, chemical, and biological soil properties (Requena et al 2001).

2 Classification and Ecology

2.1 Classification

The fungi involved in mycorrhizal symbioses are not a monophyletic entity and associations may involve any of four different fungal phyla (Pringle et al 2009). There is some segregation among plant families (see **Table 2.1**) both in the extent that each is colonized by mycorrhizal fungi and in the types of mycorrhiza that are formed (Trappe 1987, Newman et Redell 1987, Fitter et Moyersoen 1996, Wang et Qui 2006). Thus, there are two primary groups, arbuscular mycorrhizal fungi (**AMF**, = vesicular-arbuscular mycorrhiza,VAM, or endomycorrhiza) and ectomycorrhizal fungi (**EMF**) based on the differences in the morphology of their root associations, as presented in **Table 2.2** (Schwartz et al 2006; Smith et Read 2008). EMF are often further divided into two major groups: orchid (**OTM**) and ericoid (**ERM**), the latter further divided into arbutoid (**ABM**), and monotropoid (**MTM**) that correspond to the subfamilial lineages of the Heath family, Ericaceae (see Kron et al 2002; Cullings 1994, 1996).

AMF and EMF differ in traits that pertain to ecological distribution. AMF predominate in arid and semiarid regions, while EMF predominant in mesic, forested regions. With regard to host specificity, AMF tend to be generalists while EMF are relatively more selective about host species (Allen et al 1995). Even though mycorrhizal fungi are obligately associated with a host plant, they also have specific environmental requirements that seem to transcend their need for a specific plant host (Koske 1987). Some species are broad in their environmental requirements while many species are more restricted.

AMF are purportedly less specific than EMF in their associations with host plants (Allen et al 1995). However, most mycorrhizal fungi tend to be intermediate in their host specificity, being associated with one or a few plant families (Molina et al 1992). Different species of mycorrhizal fungi may occur with the same host, some physiologically segregated by seasonal activity. AMF plant communities tend to be high in plant, but low in fungal species richness, while EMF communities are low in

2 Classification and Ecology

Table 2.1 Structural and taxonomical attributes of AMF and EMF.
Data from Smith et Read 2008, Wang et Qui 2006.

	AMF	EMF				
		General	**ERM** Ericoid	**ABM** Arbutoid	**MTM** Monotropoid	**OTM** Orchid
Fungal Phylum	Glomeromycota	Ascomycota, Basidiomycota	Ascomycota	Basidiomycota	Basidiomycota	Basidiomycota
Hyphae septate	+					
Hyphyae Intracellular	+		+	+	+	+
Hyphyae Sheathing		+		+	+	
Plant Taxa						
Bryophytes	+		+			
Pteridophytes	+					
Gymnosperms						
Cycadaceae	+					
Zamiaceae	+					
Ginkgoaceae	+					
Araucariaceae	+					
Podocarpaceae	+					
Taxaceae	+					
Taxodiaceae	+					
Cupressaceae	+	*Juniperus*				
Ephedraceae	+					
Gnetaceae	+	+				
Pinaceae		+				
Angiosperms						
Monocotyledons						
General	+	rare				
Orchidaceae						+
Dicotyledons						
General	+					
Ericaceae						
Ericoideae			+			
Arbutoideae				+		
Montropoideae					+	
Betulaceae		+				
Bignoniaceae		+				
Caprifoliaceae		+				
Casuarinaceae		+				
Cistaceae		+				
Eleagnaceae		+				
Fabaceae		+				
Fagaceae		+				
Juglandaceae		+				
Malvaceae		+				
Myricaceae		+				
Myrtaceae		+				
Oleaceae		+				
Platanaceae		+				
Rhamnaceae		+				
Rosaceae		+				
Salicaceae		+				
Tiliaceae		+				
Ulmaceae		+				
Vitaceae		+				

2 Classification and Ecology

Table 2.2 Ecological attributes of AMF and EMF
Adapted from Schwartz et al 2006

Attribute	AMF	EMF
Species known worldwide	< 200, but many undescribed species are known to exist (Bever et al 2001; Clapp et al 2002)	> 5000 (Molina et al 1992)
Typical number of species found locally	< 50 (Bever et al 2001; Clapp et al 2002)	Varies from <10 to >200 (Horton et Bruns 2001)
Host plants and habitats	Herbaceous and woody plants; in many habitats from grasslands to forests, low to high latitude, on c. 90% of all plant species (Smith et Read 2008)	Woody plants in families Betulaceae, Dipterocarpaceae, Fagaceae, Myrtaceae, Pinaceae; typcially forested habitats that have lower plant diversity than AMF-dominated habitats (Smith et Read 2008)
Host specificity	Generalists with respect to ability to form association, but strong intra- and interspecific variation in relative preference for and performance with different host plant species (Bever et al 2001)	Varies widely; some are species-specific, some genus-specific, some family-specific, and some are broad generalists (Molina et al 1992)
Trophic capability	Obligate biotrophs-cannot obtain carbon without host plant association (Smith et Read 2008)	Some species have saprobic capability (Smith et Read 2008)
Spore size	Small to large (10-1000 microns) (Smith et Read 2008)	Small (usually < 15 microns) (Smith et Read 2008)
Spore dispersal mode	Aerial dispersal, animal vectors, physical soil movement (Warner et al 1987; Allen 1988; Allen 1991)	Aerial dispersal, animal vectors, physical soil movement (Allen 1991)
Colonization speed	From spores: significant variation within and among species with respect to rate of colonization (AMF: Hart et Reader 2002; EMF: Kennedy et Bruns 2005). Similar variation may exist with respect to the ability to colonize by growing from one plant root system to another.	
Growth effect on host plants	Both AM and EMF vary intra- and interspecifically with respect to impact on host plants, ranging from negative to neutral to positive (Smith et Smith 1996; Johnson et al 1997; Klironomos 2003; Jones et Smith 2004)	
Competitive ability for host plant resources	The sparse experimental evidence suggests that species vary widely in their ability to compete for access to host roots, and that competition is often asymmetric (AMF: Lopez-Aguillon et Mosse 1987; Hepper et al 1988; Pearson et al 1993; Wilson et Trinick 1983; Wilson 1984; Sen et al 1989. EMF: Wu et al 1999; Landeweert et al 2003; Kennedy et Bruns 2005. AMF vs EMF: Chen et al 2000)	

plant but higher in fungal species richness (Allen et al 1995).

The mechanisms of successional change within mycorrhizal fungal communities is little understood as yet; it is thought that differences in colonizing and persistence strategies among mycorrhizal fungal taxa account for mycorrhizal community succession and, possibly, plant community changes over time (Hart et al 2001). The type of mycorrhizal fungus may also regulate the richness of a plant community (Allen et al 1995).

2.2 Ecology

2.2.1 Ectomycorrhiza

Most ectomycorrhizal plants associate with many unrelated EMF; many EMF associate with several different plant hosts (e.g. ‘multihost’ or ‘generalist’ fungi; Bruns et al 2002; Kennedy et al 2003). Although multihost EMF dominate many ecosystems (Horton et Bruns 2001; Selosse et al 2006), there are also important specialist taxa restricted to distinct host plant groups. EMF host specificity has been well documented in several genera (see den Bakker et al 2004; Moreau et al 2006; Sato et al 2007; Nouhra et al 2008; Montecchi et Sarasini 2001; Diez et al 2002; Bruns et al 2002). It is also well established that some individual EMF species have strong host preferences (see Molina 1979; Murat et al 2004; Lian et al 2006).

The prevailing ideas about EMF host preference may be changing. Early studies of northern hemisphere ecosystems were conifer-dominated; they reported high diversity and abundance of shared EMF taxa between hosts, suggesting that ‘multihost’ fungi are dominant (Horton et Bruns 2001; Horton et al 1999, 2005; Cullings et al 2000; Kennedy et al 2003; Richard et al 2005; Twieg et al 2007; Hubert et Gehring 2008). However, this conclusion may be biased by undersampling (Dickie et Moyersoen 2008). The emerging picture is one in which many EMF appear to display some level of host preference, and most ectomycorrhizal plants host some fraction of the locally available EMF; ‘multihost’ EMF may be much less dominant than previously thought (Smith et al 2009).

EMF are considered hyperdiverse and assemble in complex and dynamic communities that are difficult to characterize (Horton et Bruns 2001; Taylor 2002). Highly diverse EMF communities dominated by rare taxa have been documented from a variety of habitats and geographic locations (Taylor 2002; Gardes et Bruns 1996; Gehring et al 1998). EMF communities associated with oak trees seem to be particularly rich (Avis et al 2003, 2008; Morris et al 2008; Walker et al 2005).

2 Classification and Ecology

Local inventory of fungal species richness provides basic information important for vegetation management decisions, such as selecting appropriate inoculants for revegetation programs. However, there is a general lack of inventory data for EMF communities throughout California.

2.2.1.1 California Plant-EMF Communities

Several recent studies have shown that plant host identity strongly influences EMF community composition. The lifespan of EMF host plant roots can span across many years, and potentially varies across species (Treseder et al 2004), but it is not clear how this affects overall EMF community structure. Spatially, many studies have observed that there is considerable small scale EMF species turnover spanning only 1 to 4 meters, or between trees (Gehring et al 1998; Jonsson et al 2000; Peter et al 2001; Tedersoo et al 2003; Lilleskov et al 2004) among years, but overall stability in the dominant species on a larger scale, such as across a sampling site (Izzo et al 2005).

To date, attempts to inventory local EMF assemblages based on soil cores sampling roots and fungal sporocarps, herbarium records, and recently fungal DNA, have been made within Fir Forests, Mixed Conifer Forests, Ponderosa Pine Forests, Douglas Fir Forests, Foothill Woodlands, Blue Oak–Interior Live Oak Woodlands, and Blue Oak Woodlands of California.

Results from these inventories show some common patterns:

- each vegetation community associates with a relatively large and diverse group of EMF ranging from 40–225 species/taxa;
- each vascular plant host tree associates with 30–500 (possibly 2000 for Douglas Fir) EMF species/taxa;
- while some EMF species/taxa are shared among different tree species at a site, more EMF species/taxa are not shared, suggesting greater host-EMF specificity than generality;
- soil temperature, soil moisture, solar exposure, litter type, litter depth, and extractable phosphorus, are driving factors for EMF presence / absence and overall site EMF diversity

Table 2.2 presents results from a few inventories of AMF and EMF made to date in California Forests and Woodlands.

Table 2.2 Inventories of AMF and EMF in California Forests and Woodlands

Community	Dominants	Hosts Sampled	Assay Method	Fungal Diversity	Host Specificity
Fir Fresno County, Teakettle Experimental Forest, Sierra Nevada, 6900ft Izzo et al 2005	White Fir Red Fir Jeffrey Pine Sugar Pine Incense Cedar	White Fir	Roots DNA	**46** EMF species/taxa EMF community fluctuated at small scales (local) across years (from fine root turnover and recolonization by by different fungi); dominant EMF more stable at larger scales and among years.	Only White Fir sampled
Ponderosa Pine Herbarium search Barroetaevela et al 2007	Ponderosa Pine	Ponderosa Pine	Herbarium records	**157** EMF species/taxa Species richness is evenly distributed among several genera.	**Genera**: 13 unique, 39 shared with Douglas Fir; **Species:** 11% shared with Douglas Fir.
Douglas Fir Herbarium search Barroetaevela et al 2007	Douglas Fir	Douglas Fir	Herbarium records	**58** EMF genera; **514** EMF species/taxa A small group of genera constitutes a high proportion of the species richness. Trappe 1977 estimated that as many as 2000 species could associate with Douglas Fir throughout the full extent of its native range.	**Genera**: 18 unique, 39 shared with Ponderosa Pine; **Species:** 11% shared with Ponderosa Pine.
Foothill Woodland Yuba County, UC Sierra Foothill Research and Extension Center Smith et al 2009; Smith et al 2007; Morris et al 2008	Blue Oak Interior Live Oak Grey Pine Alien grasses/forbs	Blue Oak Interior Live Oak Grey Pine	Sporocarp	**225** EMF species/taxa total **Pine**: 33 EMF species, 25 (78%) Basidiomycota, 8 (22%) Ascomycota; 2-9 species per lateral root; 19 of the 33 EMF (58%) were not detected on Oak; 14 occurred on both	Small number of 'multihost' taxa; dominant Pine EMF rarely associate with or have a low frequency on Oak, and most dominant Oak EMF rarely associate with or have a low frequency on Pine
Blue Oak Interior Live Oak	Blue Oak (trees) Interior Live Oak	Blue Oak Interior Live Oak	Sporocarp DNA	**140** EMF species (46 Ascomycota) total from roots & sporocarps; no AM detected **Blue Oak:** 88 EM, 54 Basidiomycota, 34	Greater diversity & frequency of taxa that produce epigeous sporocarps on the roots of Interior Live Oak

2 Classification and Ecology

2.2.2 Arbuscular Mycorrhiza

AMF tend to be generalists, displaying low specificity in their associations with host plants (Allen et al 1995). Individual morphospecies of AMF can be widespread, seemingly broad in environmental requirements (Allen et al 1995) or these may be species complexes that are similar in morphology but dissimilar in physiology (Walker 1992). Some species and genera are more restricted in their geographic distribution (Allen et al 1995). AMF do show differences in relative abundances in the rhizospheres of different plant species (Allen et al 1995).

2.2.2.1 AMF distribution along latitudinal gradients

The AMF species detected exhibited a latitudinal gradient of occurrence (Allen et al 1995). The species of AMF on the host species changed with latitude; there were distinct northern, central and southern assemblages. Different AMF formed their own assemblages on the same host plant under different environmental conditions. Two AMF taxa were wide-ranging, but most were more restricted in their geographic distribution.

2.2.2.2 AMF distribution along environmental gradients

In a large scale survey of 68 sites across the range of Big Sagebrush, *Artemisia tridentata* ssp. *tridentata*, in the western US, 48 species of AMF were detected morphologically, of which 20 were undescribed taxa (Allen et Allen, unpubl.; cited in Allen et al 1995). The range corresponds to that of Douglas Fir. At no single site were more than 17 species detected, with detection at most sites ranging between 1 and 4 species. One species occurred on 32 of 68 sites, while 20 of the 48 species were found on only one site.

2.2.3 Serpentine Soils

Serpentine soils offer inhospitable abiotic conditions to biological growth. Plant communities on serpentine soils have low levels of productivity, species richness, and plant cover, but high endemism; vegetation type tends to be distinct from adjacent non-serpentine types. The vast majority of plants tolerant of serpentine soils are mycotrophic (Alexander et al 2007; Smith et Read 2008), and associate predominantly with AMF (Schechter et Bruns 2008).

Both soil (Johnson et al 1992; Landis et al 2004; Lekberg et al 2007) and host plant specificity (Helgason et al 2002; Vandenkoornhuyse et al 2002, 2003) can exert a strong influence on mycorrhizal assemblage composition. Complex interactions among serpentine soil conditions, plant ecotypes, and mycorrhizal fungi can, but do not always, combine to

shape the composition of a mycorrhizal assemblage. Based on a limited number of investigations, it would seem that some serpentine soils do not harbor distinct mycorrhizal assemblages, whereas others do.

Studies detecting strongly distinct mycorrhizal assemblages on serpentine soils:

- EMF on Holly Oak, *Quercus ilex* ssp. *ballota* (Fagaceae), Portugal, Branco et Ree 2010;
- AMF on Few-Flowered Collinsia, *Collinsia sparsiflora* (Scrophulariaceae), California, Schechter et Bruns 2008.

Studies finding little or no differentiation of the mycorrhizal assemblage on serpentine soils:

- EMF on Oregon Oak, *Quercus garryana* (Fagaceae), southern Oregon, Moser et al 2005, 2009;
- AMF on Spike Oat, *Avenula sulcata* (Poaceae), Portugal, Fitzsimmons et Miller 2010.

3 Inoculum Production

3.1 Commercial mycorrhizal inocula

3.1.1 Products and sources

In 2001, there were more than 30 companies worldwide marketing products containing mycorrhizal fungal inocula used in horticultural, agricultural, restoration and forestry applications (Gianinazzi et Vosatka 2004). A 2011 internet search for this review found 25 companies worldwide marketing 30 products containing mycorrhizal fungal inocula. **Table 3.1** shows the geographic distribution of these 25 companies. Notably, five, or 20%, are in California: one Northern and four Southern.

Table 3.1 Geographic distribution of 25 mycorrhizal product purveyors.

Country	US State	CA City	Company
Czech Republic			**1**
France			**1**
South Africa			**1**
Switzerland			**1**
United States			**21**
	AZ		1
	CA		5
		Salinas	1
		Thousand Oaks	1
		Santa Ana	1
		Chino	1
		Palm Springs	1
	CO		1
	FL		2
	IA		1
	NM		1
	NY		1
	OR		3
	PA		2
	TN		1
	TX		1
	WA		2

3 Inoculum Production

Appendix B lists the most-available products by brand name, and shows, when stated by each manufacturer, mycorrhizal species composition, AMF/EMF membership, percent composition, original collection provenance, and product manufacturer/retailer contact data.

3.1.2 Product species composition

Taxonomic diversity in these inoculant products is low at 28 species total, with the most common AMF used being *Glomus intraradices* (60%), *Glomus mosseae* (33%), *Glomus deserticola* (23%), and *Glomus etunicatum* (20%), and the most common EMF used being *Pisolithus tinctorius* (23%). Six (20%) of the 30 products available do not provide details about mycorrhizal species composition, but indicate a mix of AMF and EMF, or AMF only, likely drawn from the same group of 28 species used commercially. Thus, frequency of the most commonly used species is likely about 15-20% higher than indicated in **Table 3.2**.

Table 3.2 Frequency of mycorrhizal species among 30 products.

Species	Group	Frequency	Percent
Glomus intraradices	**AMF**	**18**	**60 %**
Glomus mosseae	**AMF**	**10**	**33 %**
Glomus deserticola	**AMF**	**7**	**23 %**
Glomus etunicatum	**AMF**	**6**	**20 %**
Gigaspora margarita	AMF	5	17 %
Glomus clarum	AMF	5	17 %
Glomus aggregatum	AMF	4	13 %
Glomus fasciculatum	AMF	3	10 %
Glomus microaggregatum	AMF	3	10 %
Paraglomus brasilianum	AMF	3	10 %
Glomus dussii	AMF	2	7 %
Glomus monosporus	AMF	2	7 %
Glomus caledonium	AMF	1	3 %
Glomus claroideum	AMF	1	3 %
Glomus geosporum	AMF	1	3 %
Entrophospora colombiana	AMF	1	3 %
Pisolithus tinctorius	**EMF**	**7**	**23 %**
Rhizopogon amylopogon	EMF	4	13 %
Rhizopogon fulvigleba	EMF	4	13 %
Rhizopogon luteolus	EMF	4	13 %
Rhizopogon villosullus	EMF	4	13 %
Rhizopogon rubescens	EMF	2	7 %
Laccaria laccata	EMF	2	7 %
Laccaria bicolor	EMF	1	3 %
Scleroderma cepa	EMF	1	3 %
Scleroderma citrinum	EMF	1	3 %
Suillus granulatas	EMF	1	3 %
Suillus punctatapies	EMF	1	3 %
not specified	***mix***	**6**	**20 %**

3 Inoculum Production

3.1.3 Origins

Only eight (27%) of the 30 products provide any geographic origin for the mycorrhizal species used. Four products use non-GMO AMF from South Africa; three contain combinations of AMF from Arizona, California, Nebraska, and Utah; and one product uses AMF from Utah alone.

Geographic origin of mycorrhizal fungi used in commercial products is as difficult to trace as are plant cultivars available from seed or live plant vendors. The generally unspecified origins in commercial inocula may reflect the relatively few collections from wild sources now cultured by commercial labs capable of large-scale production. Cultures of AMF most commonly used in commercial inocula are maintained at the International Culture Collection of VA Mycorrhizal Fungi (INVAM) of West Virginia University, and the Glomeromycota in vitro Collection (GINCO) of arbuscular mycorrhizal (AM) fungi managed by Agriculture and Agri-Food Canada (AAFC), Ottawa, Ontario. A 2011 online search of metadata available from these two primary sources revealed that they hold few accessions from California, and that many of the commonly used *Glomus* species accessions are from eastern North America, Central America, South America, and Europe (see **Table 3.3**). If the origins of commercial inocula trace to these accessions, then nearly all of these products contain AMF genotypes alien to California.

Table 3.3 Geographic origins of source cultures available from repositories of AMF most commonly used for commercial inocula.

Collectn	GeoCode	Acc#	Continent	Country	State	Taxon
GINCO	DAOM	234281	Central America	Cuba		*Glomus clarum*
GINCO	DAOM	235359	Europe	Finland		*Glomus claroideum*
INVAM	HO	102	Europe	Holland		*Glomus aggregatum*
INVAM	UK	301	Europe	United Kingdom		*Glomus caledonium*
INVAM	UK	115	Europe	United Kingdom		*Glomus mosseae*
GINCO	DAOM	229457	North America	Canada	Ontario	*Glomus intraradices*
GINCO	DAOM	181602	North America	Canada	Quebec	*Glomus intraradices*
GINCO	DAOM	234181	North America	Canada	Quebec	*Glomus intraradices*
GINCO	DAOM	234179	North America	Canada	Quebec	*Glomus intraradices*
GINCO	DAOM	234180	North America	Canada	Quebec	*Glomus intraradices*
INVAM	AZ	243	North America	United States	Arizona	*Glomus microaggregatum*
INVAM	CA	113	North America	United States	California	*Glomus deserticola*
INVAM	FL	184	North America	United States	Florida	*Entrophospora colombiana*
INVAM	FL	239	North America	United States	Florida	*Glomus clarum*
INVAM	FL	208	North America	United States	Florida	*Glomus intraradices*
INVAM	NE	108A	North America	United States	Nebraska	*Glomus etunicatum*
INVAM	NE	202	North America	United States	Nebraska	*Glomus geosporum*
INVAM	SC	186	North America	United States	South Carolina	*Glomus claroideum*
INVAM	WV	205A	North America	United States	West Virginia	*Gigaspora margarita*
INVAM	BR	105	South America	Brazil		*Paraglomus brasilianum*

3 Inoculum Production

The only commercial inocula to explicitly state the use of a AMF collected in California are AM120 California Coastal Suite and AM120 Desert Suite (Reforestation Technologies, see **Appendix B**).

Table 3.4 Geographic origins of AMF used for AM120 products.

		AM120 Product			
AMF	**Origin**	**Standard**	**California Coastal**	**Desert**	**Basin & High Plains**
Glomus intraradices	AZ	0%	0%	**25%**	**25%**
Glomus caledonium	CA	0%	**25%**	0%	0%
Glomus deserticola	CA	0%	0%	**25%**	0%
Glomus mosseae	CA	0%	**25%**	0%	0%
Glomus etunicatum	NE	0%	0%	0%	**25%**
Glomus intraradices	UT	**100%**	**50%**	**50%**	**50%**
		100%	100%	100%	100%

3.2 Commercial production methods

Commercial production of microbial inocula is a complex procedure that involves not only the development of the necessary biotechnological expertise, but also the ability to respond to the specifically related legal, ethical, educational, and commercial requirements (Gianinazzi et Vosatka 2004). Numerous methods are used to prepare and apply mycorrhizal fungal inocula, with technical sophistication varying greatly among methods (Schwartz et al 2006).

Techniques have diversified in recent years (Douds et al 2000, Gianinazzi et Vosatka 2004). At present, commercial arbuscular mycorrhizal (AMF) inocula are produced through five different methods (see **Box 3.1**):

1. in nursery plots with soil (Sieverding 1991);
2. in containers with different substrates and plants (Feldmann et Idczak 1994, Feldmann et Grotkass 2002);
3. in aeroponic systems (Jarstfer et Sylvia 1994);
4. *in vitro* on roots (Becard et Fortin 1988, Declerck et al 1996, Adholeya et al 2003); or
5. in bioreactors using liquid fermentation (Rossi et al 2002).

3 Inoculum Production

Box 3.1 Methods for production of commercial AMF inocula

	Protocol	Advantages	Concerns
Nursery Plots	inoculated plants are cultured in open field or nursery beds	simple, adapted for local use, low costs	limited in application (high specificity); easily contaminated
Containers	containers with different substrates and plants	low technological input; some contaminations fairly easily eliminated; reasonable cost	lack of purity
Aeroponic Systems	pre-inoculated plant roots are continuously misted with nutrient solution sprayed within cultivation boxes	easier control of contaminants, carrier-free inoculum; adapted for microplants	relatively complicated technological set-up increases costs
In Vitro	*in vitro* on roots transformed with Agrobacterium rhizogenes	pure cultures; adapted to industrial development	high technological investment increases costs; not all AMF successfully culturable in this system, and suitability of inoculum produced in vitro, in particular its competitive ability toward other microbes in field soil, has yet to be tested
Bioreactors	liquid fermentation (Rossi et al 2002)		

3.2.1 Formulation of inocula

The formulation procedure consists of placing fungal propagules (root fragments colonized with AMF, fragments of fungal mycelium, and spores) in a given carrier (perlite, peat, inorganic clay, zeolite, vermiculite, sand, etc) for a given application. Because biological inoculants belong to diverse taxonomic groups and vary considerably in physiology, nutritional and environmental requirements, the final formulation is determined by the microbe involved, the way of producing inoculum, and the target inoculum application, e.g., bare-root plants, containerized plants, cuttings, seeds, etc. (Gianinazzi et Vosatka 2004). The fungi selected must be compatible with the target environment (Estaún et al 2002; Vosatka et Dodd 2002; Requena et al 1996). Following mass production, fungal propagules must be formulated in such a way that they can be stored and distributed without losing viability.

3.2.2 General concerns about industrial production

Following are the primary concerns about commercial inocula:

- producers have developed inocula using different AMF which are quite often not well characterized in terms of ecological requirements and stability (Gianinazzi et Vosatka 2004);
- the source of the fungi, with regards to the beneficial performance of the symbiosis;

- the root pieces used as inoculum are likely colonized with non-native microbial populations (Dabire et al 2007)
- potential risk of transferring pests or pathogens that could negatively affect normal plant growth and development if proper hygiene fails during production (Douds et al 2000; Gianinazzi et Vosatka 2004);
- introduction of nonlocal inoculum genotypes or alien species (Schwartz et al 2006);
- introduction of inappropriate successional stage inocula that may alter the successional trajectory and ecosystem function intended for the site (Mason et al 1983; Marler et al 1999; Richardson et al 2000).

3.2.3 Development of commercial standards

The many different kinds of formulated products available commercially implores need for established standards for accepted quality control (Gianinazzi et Vosatka 2004). Commercial products should provide the following (adapted from Gianinazzi et Vosatka 2004):

- physical and chemical properties of the inoculum, specifically, pH, nutrient carriers, and additives;
- AMF propagule density using standardized techniques (e.g. Gianinazzi-Pearson et al 1985; An et al 1990; Liu et Luo 1994) and in accordance with baseline standards;
- data regarding the effectiveness of the inoculum based on examples where the relevant inoculum has been successfully used under similar ecological conditions;
- certification that the inoculum is free of contamination from microbial plant pathogens;
- information on how to store the inoculum with recommended dates of usage and the maximum dilution of the content;
- status (presence or absence) of transgenic elements (transformed roots) used in production of the inoculum.

3 Inoculum Production

3.3 Soil transfer and stockpiled topsoil

Local mycorrhizal fungi may be added to revegetation sites through salvage, immediate transfer or stockpiling, followed by re-application of site topsoil. Strong evidence exists for physical and functional selectivity between fungus and plant responses (Helgason et al 2002; Klironomos 2003; Leake et al 2004). Sources of inocula can be critical for native plant community restoration (Klironomos 2003; Moora et al 2004). Local field AMF inoculum can be more effective for re-establishment of late-successional native plant species (Rowe et al 2007). Thus, best practices should entail matching local fungal inoculum source with targeted local native plant species. For example, soil from an *in situ* valley oak plant association transferred to valley oak seedlings planted in an adjacent restoration site (Berman et Bledsoe 1998). Matching of targeted plant community seral stages with appropriate mycorrhizal community inocula is also critical (Rowe et al 2007). See **Box 3.2** for pros and cons of soil transfer, and **Box 3.3** for pros and cons of soil stockpiling.

Best practices include:

- minimizing topsoil storage duration;
- managing construction sites for total production of mycorrhizal root material (Claassen et Zasoski 1993);
- where topsoil volume is small relative to site area, concentrating reapplication in microsites, rather than spreading soil thinly over the entire site surface (Claassen et Zasoski 1993);
- covering, stabilizing, and maintaining adequate moisture levels of stockpiles (Vogelsang et Bever).

3 Inoculum Production

Box 3.2 Soil Transfer

Application of local soils collected from undisturbed natural areas as a means of supplying mycorrhizal propagules.

Advantages

- simplest method;
- low technological requirements may be economical;
- local mycorrhizal ecotypes preserved;
- likelihood of successful native revegetation is improved with locally collected field inoculum matched to appropriate seral stage local plant species (Rowe et al 2007);
- may provide protection from deleterious factors in the receiver soil (Colinas et al 1994);
- increases ectomycorrhizal diversity (Berman et Bledsoe 1998);
- alters carbon allocation between shoots and roots so as to improve seedling survivorship (Berman et Bledsoe 1998);
- helps restore biotic interactions (e.g. Paschke et al 2003);
- improves growth and survivorship of conifer seedlings(Amaranthus et Perry 1987).

Concerns

- the whole-community inocula is undefined;
- other components in the transfer soil could include non-mycorrhizal biota such as saprobic or pathogenic fungi, soil invertebrates and prokaryotes (Schwartz et al 2006) and other organic factors such as hormones, vitamins, humic compounds and amino acids, all of which may alter the effectiveness of mycorrhiza (Slankis 1974; Bowen et Theodorou 1979; Chakraborty et al 1985);
- disruption to the rhizosphere has negative impacts to the entire community of soil biota, not just mycorrhizal fungi (Visser et al 1984a).

3 Inoculum Production

Box 3.3 Soil Stockpiling

Vegetation removal; soil horizons O and A scraped off by mechanical harvesting and dispatched to a storage area; re-application with heavy equipment; a variety of organic material, including duff, litter, fine and coarse root materials, plus the invertebrate and microbial complex, becomes disrupted and disorganized in the stockpile as a result of the procedure.

Advantages

- sustainability: topsoil is a limited resource that requires years to develop;
- enhances long-term (3 yr) plant growth on fill slopes (Claassen et Zasoski 1993);
- enhances the re-establishment of vegetation by increasing nutrient availability, water-holding capacity, and microbial activity (Hargis et Redente 1984);
- provides mycorrhizal spores and hyphal fragments which serve as inoculum for colonizing plant roots (Claassen et Zasoski 1993)

Concerns

- decomposition of organic matter during storage time
- colonization rates lower (0-38%) than in undisturbed sites (95%) (Allen et Allen 1980)
- reduction of mycorrhizal colonization potential with duration of topsoil storage:
- six months of storage: no statistically significant loss compared with freshly disturbed topsoil (Claassen et Zasoski 1993);
- 1 year of storage: 68% colonization potential, 8 years of storage: 24% colonization potential (Singleton et Williams 1979);
- 1 year of storage: 57% colonization potential, 2 years of storage: 41% colonization potential, 3 years of storage: 12% colonization potential (Liberta 1981);
- 3 years of storage: 91.7% undisturbed versus 81.7% stockpiled (statistically non-significant loss of colonization potential) (Rives et al 1980); after an additional 15 months the colonization potential of the same stockpiled soil decreased to 50.4% (Gould et Liberta 1981);
- the longer the topsoil storage time, the greater the reduction in total living soil biota (Rives et al 1980; Gould et Liberta 1981; Miller et al 1985; Stark et Redente 1987);
- managing stockpiled soil with mycorrhizal additions will not necessarily mitigate all the declines in soil quality (Vogelsang et Bever 2010);
- the vegetational history of a soil can influence species compositional patterns through a mycorrhizal feedback mechanism (Vogelsang et Bever 2009) e.g. if the soil had previously supported non-native alien annual weeds, revegetation with native plants from seed may be unsuccessful;
- although the likelihood of successful native revegetation is improved with local field inoculum, it must be matched to appropriate seral stage plant species (Rowe et al 2007);
- soil source influences mycorrhizal development and successional dynamics of vegetation (Amaranthus et Perry 1989; Helm et Carling 1993)
- weed seedbank: a site that was dominated by non-native plants, especially annuals, will have left a legacy of seeds that could maintain viability over the storage period, only to germinate and dominate the revegetation effort.

4 Efficacy of Inoculation

4.1 Efficacy of inoculation in roadside revegetation

Fungal inoculation trials used in roadside revegetation have shown mixed results, enhancing native plant restoration under some conditions, while having minimal or no effect under other circumstances (e.g. Charvat et al 2000; Vogelsang et Bever 2010). Assessment of performance frequently includes colonization potential and measures of above ground plant vigor.

Mycorrhiza are capable of colonizing disturbed sites at impressive rates, e.g. from 1% to 90% increase in a single year after inoculation (Salyards et Berry 2003), but results are inconsistent. Spore counts from reclaimed sites are not highly correlated with percent root colonization (Mosse et Bowen 1968; Daft et Nicolson 1969; Nicolson et Johnston 1979; Allen et Allen 1980). Mycorrhizal inoculum potential depends on more than just the numbers of spores present. The conditions for the expression of mycorrhizal effectiveness are poorly known, leading to inconsistency in response to AMF inoculation (Ryan et Graham 2002).

To achieve consistent results factors controlling effectiveness of an AMF strain need better delineation (Herrera-Peraza et al 2010). Multiple factors in the biotic and abiotic environment are implicated in the variation in the outcome of fungal inoculation:

4.1.1 Host plant species and ecotype

There is considerable variation in the mycorrhizal responsiveness of potential host plants. The functional specificity that exists between plants and AMF has been well documented (Helgason et al 2002; Klironomos 2003; Leake et al 2004). Degree of host-plant dependence ranges from nonmycotrophic, facultatively mycotrophic (varying from weak to strong), to obligately mycotrophic; dependence correlates somewhat with plant life history (annual versus perennial), taxonomical group, and phenological guild [physiological seasonality] (Wilson et Hartnett 1998).

4 Efficacy of Inoculation

4.1.2 Fungal species and genotype isolate

Fungal isolates are highly diverse with respect to effectiveness; not all mycorrhizal fungi are equally effective. Enormous variability exists among species of ectomycorrhizal fungi in physiological attributes such as the utilization of organic nitrogen sources (e.g., Abuzinadah et Read 1986) and tolerance of water stress (e.g., Coleman et al 1989). The influence of the soil environment on AMF isolates has been documented but is not yet well understood (Feddermann et al 2010).

The variance in mycorrhizal effectiveness may also be due to the industrial production system. Commercially produced mycorrhizal products will include only fungal isolates that are most conducive to large-scale production. During such production of selected strains there is always a risk of loss of the desirable qualities originally selected for (Gianinazzi et Vosatka 2004). There is no reason to assume that production efficacy of a fungus corresponds with its ability to increase target host plant vigor (Schwartz et al 2006).

4.1.3 Edaphic factors

The soil environment imposes a strong influence on AMF functionality (Arines et al 1988; Frey et Ellis 1997; Hamel 2007; Warnock et al 2007; Mechri et al 2008; Helgason et Fitter 2009) and is likely a key determinant of AM fungal effectiveness (Herrera-Peraza et al 2010). Studies have shown that plant response to inoculation varies among soil types (Young et al 1986; Hamel et al 1997; Zeuske et Weber 2000; Schreiner 2007). The soil not only provides mineral nutrients to AMF, but also constitutes the physicochemical environment where both these fungi and their plant associates live (Herrera-Peraza et al 2010). Conditions such as soil moisture, temperature, and pH (Nicolson 1960; Slankis 1974), nutrient level and nutrient balance (Daft et Nicolson 1966; 1969; Mosse et Phillips 1971; Mosse et al 1976; Sparling et Tinker 1978; Smith et Read 2008; Liu et al 2000; Fitzsimons et al 2008), and organic matter plus other organic factors such as hormones, vitamins, humic compounds and amino acids, alter the effectiveness of mycorrhiza (Slankis 1974; Bowen et Theodorou 1979; Chakraborty et al 1985). Changes in AMF community composition have been linked to differences in soil organic matter, nitrogen-to-phosphorous ratio, bulk density, and pH (Corkidi et al 2002; He et al 2004; Fitzsimons et al 2008). Edaphic factors have also been shown to influence AMF development (Abbott et Robson 1991), sporulation (Baum et al 2002), and function (Karasawa et al 2001).

Performance of AMF may be limited to a range of specific soil environmental conditions; thus, the effectiveness of AMF symbioses may depend on the compatibility between AMF strain and the soil

environment (Herrera-Peraza et al 2010). Selecting AMF strains based on target soil properties, e.g. soil taxonomic groups, may improve the consistency in effectiveness of inoculants. Also, the entirety of the microbial organism system of the soil influences AMF (Nicolson 1960).

4.2 Detrimental affects on host plants

Because mycorrhizal fungi have been generally considered to be mutualistic, there has been little concern over potential negative consequences of their introduction. While the promise of benefit to the mycorrhizal host plant has long been accepted as standard, some studies indicate that a wide range of host responses to AMF and EMF is possible (Smith 1980, Johnson et al 1997; Burgess et al 1994; Jones et al 2003). The fungal component of the symbiosis can function along a continuum of activity from mutualism to commensalism to parasitism (Smith 1980; Smith et Smith 1996; Johnson et al 1997; Zhou et Sharik 1997; Klironomos 2003; Jones et Smith 2004) and host plants can be affected negatively as a consequence of the symbiosis.

Inconclusive and conflicting data regarding benefit to the host plant may be a result of complications inherent in mycorrhizal research (Jones et Smith 2004):

4.2.1 Defining and quantifying ‘benefit’

Benefit to the host plant has been variously defined by different workers to include carbon gain, nutrient acquisition, seedling survivorship, growth pattern, fitness, etc. Each of these involves a different metric and the different measures are not necessarily correlated (e.g. plant growth does not always predict fitness). Taken alone, any single factor is unlikely to explain the full complexity of ‘benefit’ and confounds interpretation of results among studies. ‘Benefit’ varies with symbiont genotypes and multiple conditions of the abiotic and biotic environments, such that no simple indicator consistently predicts outcome.

4.2.2 Variation in spatiotemporal scales

Differences in spatiotemporal scales among studies adds to the confusion. The selection of the scale at which any investigation is undertaken serves to bias the results in some way. Benefits may be highly spatially and temporally variable (Jones et Smith 2004). The spatial component of mycorrhizal investigation may span from the community, individual plant, to cellular activity level. Equally significant is the timeframe over which an analysis is conducted. The time frame required to assess benefit beyond the survivorship of young plants is often longer than available (Jones et Smith 2004). Benefit is not

necessarily constant seasonally or over the lifespan of the plant. Some mycorrhizal fungi have no effect on or even suppress growth under some conditions and yet increase host plant fitness over the long term (Copeman et al 1996; Normand et al 1996; Koide et al 1988; Philip et al 2001; Streitwolf-Engel et al 1997). Mycological symbioses may benefit the host plant for very brief, but critical, periods.

4.2.3 Methodological constraints

Assessment of host plant benefit suffers from the difficulties inherent in most ecological studies. In field experiments it is difficult to control the system of biotic soil conditions in a manner that reflects a realistic environment. The complexity of the interactions among plants and mycorrhizal fungi in the field is enormous because of the high biotic diversity. Some controlled studies using nursery beds in the field indicate that mycorrhiza do improve seedling survival (Hatch 1936; Young 1936; Rayner 1938; Roldan-Fajardo 1994). However, many studies on the survival of EMF or AMF seedlings in the field are primarily correlative, precluding the separation of cause and effect, and, thus, limited to circumstantial evidence (see for example Allen 1987, Miller et al 1998, Zak et al 1998).

Greenhouse investigations can more readily control biotic soil conditions, but such conditions are highly artificial. Most published studies on the effect of mycorrhiza on seedling survival under laboratory conditions use micropropagated plants during the acclimation phase when they are transplanted (Jones et Smith 2004); a notable exception (Grime et al. 1987) demonstrated that the AMF species seedlings from a calcareous grassland in the UK had higher survival rates with inoculation.

Plant growth has been used as a measure of benefit even though this measure is not necessarily correlated to fitness. Outcomes vary. Different plant-fungus combinations have been shown to stimulate, depress, or have no effect on the host plant’s growth patterns (van der Heijden et al 1998; Bever et al 2002; Hart et Klironomos 2002; Peterson et Massicotte 2004; Antolin 2008). Also, plant density or degree of plant cover has been shown to alter AMF effectiveness (Fitter 1977).

Fecundity has been also used as a measure of benefit. In greenhouse studies the effects have been inconclusive, confirmed by some (Daft et Okusanya 1973; Stanley et al 1993; Shumway et Koide 1994; Koide et Lu 1995; Heppell et al 1998), but shown by others to be ineffective or even negative (Philip et al 2001). Studies comparing the fecundity of mycorrhizal and nonmycorrhizal plants in the field under natural

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conditions are few and yield inconsistent results (Carey et al 1992; Shumway et Koide 1995).

In summary, mycorrhizal symbioses may benefit the each partner at different times during their lifespan, and possibly, for very short, but critical, periods. Benefits to both plant and fungus are likely to vary extensively depending on the genotypes of the fungus and plant, and the environment in which they live.

In order to delineate a Caltrans specification for use of mycorrhizal inocula, predicting the outcome is a necessary priority. Determining whether a specific association benefits the host symbiont under highly variable field conditions would require a level of information about both site, symbionts, and their interactions that is not yet available.

5 Potential Consequences

5.1 Potential unintended consequences

The intentional use, culture, and dispersal of mycorrhizal fungal species hold potential for unintended negative consequences similar to those that accompany any introduction of extralimital plant or animal species.

AMF introductions have the potential to be invasive, with the capability of, directly or indirectly, suppressing or displacing resident AMF populations and/or through the introduction of pathogens associated with the inoculants. When fungi are independently introduced to a novel habitat, or when plants are moved with intact root systems, even highly specific symbioses will not necessarily be a barrier to spread (Pringle et al 2009).

Mycorrhizal fungi not only influence individual plant performance and the composition of plant communities, they are also integral components of ecosystem functioning. They have known or putative influences on a broad variety of processes, including soil aggregation, nutrient cycling, primary production, and carbon storage (Rillig 2004). Unfortunately, in most cases the relative contribution of mycorrhiza to a particular process rate is not yet known (van der Heijden et al 2008). Consequences of novel inoculations on the structure of resident/native communities may lead to shifts in functional outcomes.

5.1.1 Non-native species introductions

Globalization of biota (non-native species introductions) has resulted in:

ecological degradation and degraded ecosystem services
(Mack et al 2000)

Introduced EMF in Monterey Pine plantations in Ecuador has significantly disrupted the soil carbon storage cycle (Chapela et al 2001). This was not consistent with the biology of the fungus in its native habitat and has strong implications for the desire to sequester carbon dioxide from the atmosphere globally (Schwartz et al 2006). Earthworm invasion to North America

have resulted in dramatic ecosystem effects (James 1991; Bohlen et al 2004).

Invasive species and their novel interactions with the existing biota can result in strong selection, and rapid evolution with unpredictable interspecific interactions (Parker et Gilbert 2004).

biodiversity losses

(Schwartz et al 2006)

Introduced mycorrhizal fungi may directly affect local diversity of fungal communities and indirectly influence plant community composition (Schwartz et al 2006). Several studies have shown that exotic EMF are highly persistent in their novel environments (e.g. De La Bastide et al 1995; Selosse 1997; Selosse et al 1998a,b, 1999) and colonize nearby uninoculated native plants (Selosse et al 1999; Diez 2005; Fuhrer et Robinson 1992).

Even if care is taken to introduce fungal species that may already be present in native habitats, problems may arise owing to "cryptic" ecotypic differences. Novel genotypes may outcompete native genotypes and spread beyond the site of introduction, and may interact differently than native genotypes with native hosts, soil communities, and abiotic conditions. Different strains of mycorrhizal fungi vary widely in their responses to the environment and in the benefits they provide to host plants (e.g. Cairney 2002), and there is evidence that some local genotypes of mycorrhizal fungi may be better adapted to their native environment and/or may provide greater benefits to their native host plants than non-local genotypes (e.g. Gildon et Tinker 1983; Stahl et Smith 1984). If novel genotypes out-compete local strains, locally adapted combinations of fungi and their host plants may be disrupted (Schwartz et al 2006).

increased biotic homogenization

(McKinney et Lockwood 1999)

Introduced genotypes of the same strain of mycorrhizal fungi as native genotypes could result in hybridization or introgression, as has happened with fungal symbionts in Douglas Fir plantations in Europe (Mueller et Gardes 1991; De La Bastide et al 1995). Hybridization or introgression between introduced and native populations of plants and animals have significant negative consequences for the native populations, including extinction (Rhymer et Simberloff 1996).

5 Potential Consequences

costly management of noxious invaders

(Pimentel et al 2000; Pimentel et al 2005)

Noxious problem species cost societies billions of dollars per year (US Congress, Office of Technology Assessment 1993; Naylor 2000; Pimental et al 2000).

Many factors influence an organism's ability to invade, and these are not yet well understood. Mycorrhizal symbioses may well be one of the factors that critically influence the trajectory of a plant invasion (Vogelsang et Bever 2009). Pringle et al (2009) detail seven critical aspects of the symbioses of plants and mycorrhizal fungi that will influence the trajectory of a plant species invasion. Research suggests that the mycorrhizal status of plants plays a different role in plant invasions among geographic regions (Pringle et al 2009).

Introduced AMF may contribute to plant invasions if invasive plants benefit more from the introduced fungi than the native plant species (Schwartz et al 2006). For example, 1) it appears that Cheatgrass, *Bromus tectorum*, may more readily invade sagebrush steppe of the United States when forming arbuscular mycorrhiza (Richardson et al 2000) and 2) competitive exclusion of native grasses by spotted knapweed may involve facilitation by AMF (Marler et al 1999). The presence of AMF may also stimulate greater seed production by invasive annual grasses such as Soft Chess, *Bromus hordeaceus* (Antolin 2008). A plant-soil feedback mechanism can alter vegetational composition to disfavor highly AMF-dependent native plant species (Vogelsang et Bever 2009) and, conversely, a change in the composition of a mycorrhizal fungal community may also inhibit plant invasion (Bever et al 2002).

Facilitation of invasive plants by mycorrhizal fungi are also likely with EMF, as with the introduction of *Eucalyptus* spp. in the US—and listed on invasive weed lists—(Richardson et al 2000) where it is colonized almost exclusively by fungal species or strains of Australian origin (Diez 2005).

Following their successful establishment, invasive plants are influenced by (and can influence) their own (and neighboring) mycorrhizal symbioses, and these can further influence the trajectory of the invasion, with repercussions on the native communities of plants and microbes (Pringle et al 2009).

As of 2006, there were no documented cases where the intentional movement of mycorrhizal fungi has led directly to a widespread,

persistent invasive species problem (Schwartz et al 2006). However, this lack of knowledge may be due to either the absence of problems or the absence of detection. Undesirable effects may be present, but may go unnoticed because: 1) large-scale monitoring of the consequences of inoculation is rarely conducted; 2) the fungi are underground and essentially invisible; and 3) cryptic genetic species may not appear morphologically different, but may impact or displace the native species, or, 4) through altered biogeochemistry, there may be subtle, but significant ecosystem consequences (Schwartz et al 2006). The classical, microscopy procedures used to identify AMF are not adequate for effectively monitoring the inoculum. Simple, but reliable, molecular probes to identify AMF to the level of ecotypic strains would be required (Gianinazzi et Vosatka 2004)

5.1.2 Effects on plant community composition

The functional specificity that exists between plants and AMF has been well documented (Helgason et al 2002; Klironomos 2003; Leake et al 2004). Recent work has demonstrated a fundamental role of AMF in the organization of terrestrial ecosystems (Hart et al 2001).

Multiple species of AMF co-exist in terrestrial ecosystems; co-occuring plants differ in their response to colonization by these fungi and in their symbiotic growth response (Klironomos 2003). This high variation in responsiveness may be a regulator of plant species co-existence and the structure of plant communities (Klironomos 2003).

Of the taxa examined, late-successional plant species are generally more responsive to mycorrhizal colonization than early-successional plant species (Allen 1984; Allen et Allen 1984, 1988, 1990; Allen et al 1995; Reeves 1985; Miller 1987; Reeves et Redente 1991; Wilson et Hartnett 1998; Hart et al 2001; De Deyn et al 2003; Klironomos 2003; Rowe et al 2007).

To manipulate plant community composition, necessary for restoration ecology, landscape management, or revegetation, the biological/ecological rules governing AMF dynamics must be elucidated (Hart et al 2001).

5.1.3 Effects on soil microflora

Little is known about the response of soil microbial functional diversity to AMF inoculation (Dabire et al 2007). Some novel AMF isolates are very competitive against native microflora (Duponnois et al 2005a; Sanon et al 2006; Dabire et al 2007). Because soil microbial activities include decomposition, nutrient transformation, plant growth promotion/suppression, and modification of soil physical processes

(Giller et al 1997; Wardle et al 1999), the role of soil microbial diversity may be a major factor contributing to the maintenance of plant diversity and to ecosystem functioning (van der Heijden et al 1998).

An introduced inoculum can induce disequilibria in microbial functionalities (Dabire et al 2007) and might increase the susceptibility of soil microflora to stress and disturbance (Degens et al 2001). AMF inoculations have reduced soil catabolic evenness (Dabire et al 2007) and microbiological activities which contribute to soil quality.

Some have long felt that soil microbial modifications induced by introduced AMF inoculum should be considered in revegetation strategies (Franson et Bethlenfalvay 1989).

5.1.3 Effects on local vegetation succession

Extensive below-ground surveys since about 1900 have confirmed the presence of mycorrhizal symbioses in most, but not all, successional stages of many plant associations, and in most plants present in mature biomes throughout the world (Smith et Read 2008). Research suggests that the functional attributes of these symbioses go far beyond simple scenarios involving facilitation of mineral nutrient capture by individual plants, or of organic carbon uptake by the fungal associate (Smith et Read 2008). Depending upon environmental conditions mycorrhizal fungi may hasten or impede succession (Allen et Allen 1988).

Here are a few of the trends identified thus far relative to succession:

- pioneer fungi have been observed to drive primary succession;
- sufficient fungal propagule availability is essential
  - wind is a primary vector of fungal spores in arid Western North America—AMF spores travel at least 2 km (Warner et al 1987);
  - animals disperse AMF spores over several kilometers (Allen 1987);
  - proximity of established vegetation provides local sources of mycorrhizal propagules (spores or plant root fragments with hyphae);
  - local field AMF inoculum can be more effective for re-establishment of late-successional native plant species; likelihood of successful native revegetation is improved with locally collected field inoculum matched to appropriate seral stage local plant species (Rowe et al 2007);
- nutrient impoverishment is often coincident with primary succession;

5 Potential Consequences

- nutrient sufficiency is often concurrent with secondary succession;
- Any disturbance that disrupts mycorrhizal mutualisms could facilitate the establishment of non-native plants (Vogelsang et Bever 2009);
- Disturbed sites of California are typically colonized by largely non-mycorrhizal or facultatively mycorrhizal species of mustards (Brassicaceae/Cruciferae), goosefoots (Chenopodiaceae), knotweeds and buckwheats (Polygonaceae), cheeseweeds (Malvaceae), or cool-season annual grasses (Poaceae/Gramineae, e.g., species of *Avena, Brachypodium, Bromus, Festuca/Vulpia, or Hordeum*);
- The relative success of plant species on a disturbed site depends on the availability and identity of AMF on the site (Allen 1984a, 1987; Allen et al 1995; Miller 1987);
- AMF-dependent plant species are more negatively affected than species with weak mycorrhizal associations (Stark et Redente 1987);
- If AMF are introduced for purposes of native revegetation, it is imperative to know the responsiveness of both target native plant species and invasive plant species on-site (Rowe et al 2007);
- When the goal of ecological restoration or revegetation is to improve conditions for late-successional species, this needs to include an appropriate AMF community. For native plant community restoration, the source of the AMF can be important (Klironomos 2003; Moora et al 2004);
- Late successional species are generally more responsive to mycorrhizal colonization than early successional plant species Allen 1984; Allen et Allen 1984, 1988, 1990; Allen et al 1995; Reeves 1985; Miller 1987; Reeves et Redente 1991; Wilson et Hartnett 1998; Hart et al 2001; De Deyn et al 2008; Klironomos 2003);

Longer term effects on plant community structure and composition from mycorrhizal dynamics are unpredictable from the few local studies involving responses by individual plant species. Evidence exists for transfer of nutrients and water among plants sharing a fungal mycelial network at study sites, but how these networks affect local competitive interactions among individual plants has not been well documented (Smith et Read 2008). Critical questions concerning the role of mycorrhiza in facilitating plant establishment on disturbed sites are answerable ultimately through field experimentation.

6 Recommendations

Evidence from research indicates clear potential for non-indigenous mycorrhizal fungi to persist and invade non-target habitats. These invasions may have positive, neutral, or negative effects on plant growth, local fungal and plant communities and ecosystem processes. Assumption that all interactions with mycorrhizal fungi will result in positive or negligible effects is no longer prudent (Schwartz et al 2006). With ecological studies documenting potential serious negative consequences of inoculation, research results are needed that elucidate the best management practice for mycorrhizal treatments before statewide specifications can be written.

A general lack of site-specific data about how local variability among plant genotypes, mycorrhizal genotypes, and soils interact at a project site renders a single all-inclusive statewide standard specification for mycorrhizal inoculation inadvisable at this time.

Revegetation by design, especially in summer-dry California climates, is always precarious and unpredictable. Interactions among weather, soils, plants, fungi—and outcomes dependent on community assembly rules, initial conditions, chaos, and stochasticity—thwart simple specification of biological components for a project site. Sustainable designs require local, context-dependent solutions involving local soils and local plant and fungal genotypes. However, for most local sites, specification of pioneer plants and fungi is still guesswork, and California does not have a systematic statewide infrastructure in place to collect and increase local plant and fungal propagules for reintroduction.

Based on current knowledge, the following Best Management Practices and Potential Policies regarding mycorrhiza are presented as unofficial recommendations.

6 Recommendations

6.1 Best Management Practices

6.1.1 Where Local Topsoil is Available

Balance pros and cons of soil transfer or stockpiling (SSP 20-170 Local Topsoil) as a means to reapply local mycorrhizal fungi and native plant propagules.

Proper matching of targeted plant community species and community seral stages with appropriate mycorrhizal community inocula is critical. If a site is a relatively weed-free, undisturbed native plant site, then stockpile topsoil with local seeds, spores, and bacteria, and reapply as quickly as possible. Seedbank analysis by a reputable seed lab is essential to ascertain presence and relative quantities of native and alien plant species.

Reapplied topsoil can be treated according to project objectives with standard soil surface protection measures that may include:

- SSP 20-055 Compost Blanket
- SSP 20-356 Jute Mesh
- SSP 20-060 Fiber Rolls
- SSP 20-040 Hydroseed
- SSP 20-049 Seeding (Hand Applied)
- SSP 20-070 Seedling.

6.1.2 Where Local Topsoil is Not Available

Adequate physical erosion control

Subsoil or non-local fill is very unlikely to support enough revegetation in the first few growing seasons to provide sufficient soil surface protection. Instead, physical erosion control measures for such sites must be designed to provide sufficient erosion control over the first few years. A combination of SSP 20-055 Compost Blanket, SSP 20-356 Jute Mesh, and SSP 20-060 Fiber Rolls, would likely provide adequate erosion control for at least two years. Supplementary plant materials can be added at the appropriate time according to SSP 20-040 Hydroseed, SSP 20-049 Seeding (Hand Applied), SSP 20-070 Seedling, or a combination thereof.

Specify native pioneer species for revegetation

Subsoil or non-local fill typically contains either inadequate or inappropriate soil bacteria, fungi, invertebrates, or other biota, for the vascular plant species seeded or planted at a project site. Mycorrhizal formation may be impeded or prevented by host-fungus mismatches.

6 Recommendations

Plant species selected for revegetation of such sites should be pioneers known to be nonmycorrhizal, or facultatively mycorrhizal with generalist AMF or EMF. For most of lowland cismontane California, the following list of typical pioneer plant species meet these requirements.

Duration	Lifeform	Legume	Scientific Name	Vernacular Name
Perennial>3Yr	Shrub	No	Artemisia californica Less.	California Sagebrush
Perennial>3Yr	Shrub	No	Eriogonum fasciculatum Benth.	California Buckwheat
Perennial>3Yr	Shrub	No	Salvia mellifera E.L.Greene	Black Sage
Perennial>3Yr	SubShrub	No	Eriophyllum confertiflorum (DC.) A.Gray	Golden Yarrow
Perennial>3Yr	SubShrub	Yes	Lotus scoparius (Nutt.) Ottley	Deer Lotus
Perennial>3Yr	Forb	No	Achillea millefolium L. subsp. lanulosa (Nutt.) Piper	Western Yarrow
Annual	Forb	No	Lasthenia californica DC. ex Lindl.	California Goldfields
Annual	Forb	No	Layia platyglossa (Fisch. et C.A.Mey.) A.Gray	Coastal Tidytips
Annual	Forb	Yes	Lotus purshianus (Benth.) Clements et E.G.Clements	Spanish Lotus
Annual	Forb	Yes	Lupinus bicolor Lindl.	Bicolor Lupine
Annual	Forb	Yes	Lupinus nanus Dougl. ex Benth.	Sky Lupine
Annual	Forb	Yes	Lupinus succulentus Dougl. ex K.Koch	Arroyo Lupine
Annual	Forb	No	Nemophila menziesii Hook. et Arn.	Baby Blue Eyes
Annual	Forb	Yes	Trifolium willdenovii Spreng.	Tomcat Clover
Perennial>3Yr	TrueGrass	No	Agrostis diegoensis Vasey	San Diego Bentgrass
Perennial>3Yr	TrueGrass	No	Nassella lepida (A.S.Hitchc.) Barkworth	Foothill Needlegrass
Perennial>3Yr	TrueGrass	No	Nassella pulchra (A.S.Hitchc.) Barkworth	Purple Needlegrass
Perennial<3Yr	TrueGrass	No	Bromus carinatus Hook. et Arn.	California Brome
Perennial<3Yr	TrueGrass	No	Elymus glaucus Buckley	Blue Wildrye
Annual	TrueGrass	No	Vulpia microstachys (Nutt.) Munro in Benth.	Small Fescue
Annual	TrueGrass	No	Vulpia octoflora (Walt.) Rydb.	Sixweeks Fescue

Other native species of the genera *Ambrosia, Artemisia, Atriplex, Chenopodium, Clarkia, Elymus, Eriogonum, Eriophyllum, Gilia, Gutierrezia, Lotus, Lupinus, Malacothamnus, Oenothera, Phacelia, Plantago, Salvia, and Sphaeralcea,* are appropriate pioneers also.

Consider whether each proposed application of mycorrhizal inoculum is necessary and potentially positive for the plant community (from Schwartz et al 2006).

Mycorrhizal fungi are ubiquitous and abundant. Both AMF and EMF may be eliminated from severely disturbed construction sites or eroded slopes such that inoculation with mycorrhizal fungi may be necessary for successful reclamation or restoration (Jasper et al 1987; Lumini et al 1994). Where abundance and diversity of natural inoculum is low owing to project construction, inoculation may be warranted. Numerous biotic and abiotic edaphic factors influence the response of inoculation; these factors, some as simple as soil nutrients, should be identified and quantified before the addition of mycorrhizal inoculum (Charvat et al 2000).

6 Recommendations

6.2 Potential Policies

Adopt policy that favors the use of local fungal genotypes through local production of AMF inoculum using existing protocols that ensure pathogen-free production (from Schwartz et al 2006).

A conservative approach to managing biotic integrity is to recommend utilizing indigenous mycorrhizal fungi that are already present in the soil (Trappe 1977; Abbott et Robson 1982; Sylvia et Burks 1988; Berman et Bledsoe 1998; Douds et al 2000). When mycorrhizal fungal propagules are absent, or in extremely low densities, then inoculum containing local strains of mycorrhizal fungi should be developed and utilized. Native ecotypically-specific mycorrhizal inoculum has outperformed commercial inoculum in the reduction of soil erosion on fill slopes by enhancing root growth and increasing biotic activity in the rhizosphere (Vogelsang et Bever 2010).

Restrict the use of non-indigenous fungi to when local strains or species are unavailable or incompatible with the target plant species. If non-indigenous fungi are used, then steps should be taken to minimize the risk of introducing mycorrhizal fungi that could become problem invasive species. For such situations, isolates used for inoculation should be selected to have the following traits:

- high benefit to target host plant(s)
- high specificity to target host plant(s)
- among EMF, low ability to utilize non-host carbon sources, in order to reduce the opportunity for EMF to exist as partial saprobes in introduced habitats
- rapid colonization ability, for ease of inoculation
- low dispersal ability, to reduce potential for encroachment into non-target habitats
- poor long-term competitive ability which would allow inoculation and establishment of host plants, followed by extirpation of the introduced fungus by native fungi.

Unfortunately, sufficient data on these traits for specific fungal strains to allow for selection of fungi have yet to be empirically developed (Schwartz et al 2006).

6 Recommendations

Promote development of commercial standards for mycorrhizal inocula by insisting that producers explicitly state the following (adapted from Gianinazzi et Vosatka 2004):

- physical and chemical properties of the inoculum, specifically, pH, nutrient carriers, and additives;
- AMF propagule density using standardized techniques (e.g., Gianinazzi-Pearson et al 1985; An et al 1990; Liu et Luo 1994) and in accordance with baseline standards;
- data regarding the effectiveness of the inoculum based on examples where the relevant inoculum has been successfully used under similar ecological conditions in California;
- certification that the inoculum is free of contamination from microbial plant pathogens;
- information on how to store the inoculum with recommended dates of usage and the maximum dilution of the content;
- status (presence or absence) of transgenic elements (transformed roots) used in production of the inoculum.

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Appendix A

Mycorrhizal occurrence among land plants

Examined species[a]	Mycorrhizal status[b,c]	References
BRYOPHYTES		
Haplomitriaceae		
Haplomitrium gibbsiae	AM-like	107
Haplomitrium ovalifolium	AM-like	107
Blasiaceae		
Blasia pusilla	None	182, 328
Lunulariaceae		
Lunularia cruciata	Fungal association (G)	182
Marchantiaceae		
Marchantia foliacea	AM-like	505
Marchantia polymorpha	Fungal association (G)	182
Aytoniaceae		
Asterella wilmsii	AM-like	345
Conocephalaceae		
Conocephalum conicum	AM-like	346
	Fungal association (G)	182
Ricciaceae		
Riccia fluitans	None	182
Metzgeriaceae		
Apometzgeria pubescens	None	466
Metzgeria conjugata	None	466
Metzgeria fruticulosa	None	466
Metzgeria furcata	None	466
Metzgeria leptoneura	None	466
Metzgeria temperata	None	466
Aneuraceae		
Aneura pinguis	ORM-like (B)	347
Cryptothallus mirabilis	Fungal association	466
	ORM-like (B)	347
	Mycoheterotrophy (via ECM)	77, 483
Riccardia latifrons	None	466
Riccardia multifida	None	466
Riccardia palmate	None	466
Pelliaceae		
Pellia endiviifolia	AM-like	598
Pellia epiphylla	Fungal association (G)	182
Pellia fabbroniana	AM-like	483
Codoniaceae		
Fossombronia pusilla	Fungal association (G)	182
Fossombronia wondraczekii	Fungal association	328
Radulaceae		
Radula aquilegia	None	466
Radula complanata	None	466
Radula lindbergiana	None	466
Porellaceae		
Porella arboris-vitae	None	466
Porella cordaeana	None	466
Porella obtusata	None	466
Porella pinnata	None	466
Porella platyphylla	None	466
Jubulaceae		
Frullania dilatata	None	466
Frullania fragilifolia	None	466
Frullania microphylla	None	466
Frullania tamarisci	None	466
Frullania teneriffae	None	466
Jubula hutchinsiae	None	466
Lejeuneaceae		
Aphanolejeunea microscopica	None	466
Cololejeunea calcarea	None	466
Cololejeunea minutissima	None	466
Colura calyptrifolia	None	466
Drepanolejeunea hamatifolia	None	466
Harpalejeunea ovata	None	466
Lejeunea cavifolia	None	466
Lejeunea lamacerina	None	466
Lejeunea patens	None	466
Lejeunea ulicina	None	466
Marchesinia mackaii	None	466
Pseudolepicoleaceae		
Blepharostoma trichophyllum	None	466
	Fungal association	328
Herbertaceae		
Herbertus borealis	None	466
Plagiochilaceae		
Pedinophyllum interruptum	None	466
Plagiochila asplenioides	None	466
Plagiochila porelloides	None	466
Plagiochila punctata	Fungal association	466
Plagiochila spinulosa	None	466
Arnelliaceae		
Southbya nigrella	Fungal association (B)	182
Geocalycaceae		
Chiloscyphus pallescens	None	466
Chiloscyphus polyanthus	None	466
Geocalyx graveolens	Fungal association	466
Harpanthus flotovianus	None	466
Harpanthus scutatus	Fungal association	466
Leptoscyphus cuneifolius	None	466
Lophocolea bidentata	None	466
Lophocolea cuspidate	None	466
Lophocolea heterophylla	None	182, 466
	Fungal association	328
Saccogyna viticulosa	Fungal association	466

Examined species[a]	Mycorrhizal status[b,c]	References
Lepidoziaceae		
Bazzania flaccida	None	328
Bazzania tricrenata	None	466
Bazzania trilobata	None	328, 466
Kurzia pauciflora	Fungal association	466
	Fungal association (A)	182, 328
Kurzia sylvatica	Fungal association	466
Kurzia trichoclados	Fungal association	466
Lepidozia reptans	Fungal association	466
	Fungal association (A)	182, 328
Telaranea murphyae	Fungal association	466
Telaranea nematodes	Fungal association	466
Scapaniaceae		
Diplophyllum albicans	None	182, 466
	Fungal association	328
Diplophyllum obtusifolium	Fungal association	328
Douinia ovata	None	466
Scapania calcicola	None	466
Scapania cuspiduligera	None	466
Scapania gracilis	None	466
Scapania scandica	None	466
Scapania umbrosa	None	466
Cephaloziellaceae		
Cephaloziella baumgartneri	None	466
Cephaloziella divaricata	Fungal association	466
	Fungal association (A)	182, 328
Cephaloziella exiliflora	Fungal association (A)	118
Cephaloziella hampeana	Fungal association	466
Cephaloziella massalongi	None	466
Cephaloziella rubella	Fungal association	466
Cephaloziaceae		
Cephalozia bicuspidate	Fungal association	466
	Fungal association (A)	182, 328
Cephalozia catenulate	None	466
	Fungal association	328
Cephalozia connivens	Fungal association	466
	Fungal association (A)	182
Cephalozia leucantha	Fungal association	466
Cephalozia loitlesbergeri	Fungal association	466
	Fungal association (A)	182
Cephalozia lunulifolia	Fungal association	328, 466
Cephalozia macrostachya	Fungal association	466
Cephalozia pleniceps	Fungal association	466
Cladopodiella fluitans	None	466
Cladopodiella francisci	Fungal association	466
Nowellia curvifolia	Fungal association (A)	182, 328, 466
Odontoschisma denudatum	None	466
	Fungal association (A)	182
Odontoschisma elongatum	None	466
Odontoschisma sphagni	Fungal association	466
	Fungal association (A)	182
Calypogeiaceae		
Calypogeia arguta	Fungal association	466
Calypogeia azurea	Fungal association (A, B)	328
Calypogeia fissa	Fungal association	466
	Fungal association (A)	182
Calypogeia integristipula	Fungal association	328
Calypogeia muellerana	Fungal association	466
	Fungal association (A)	182
	Fungal association (A, B)	328
Calypogeia neesiana	Fungal association	328, 466
Calypogeia sphagnicola	Fungal association	466
Calypogeia trichomanis	Fungal association	466
Jungermanniaceae		
Anastrophyllum minutum	Fungal association	328
Barbilophozia barbata	Fungal association (A, B)	328
Barbilophozia hatcheri	None	466
Jamesoniella autumnalis	Fungal association	466
Jamesoniella undulifolia	None	466
Jungermannia atrovirens	None	466
Jungermannia borealis	None	466
Jungermannia exsertifolia	None	466
Jungermannia gracillima	None	182, 466
Jungermannia obovata	None	466
Jungermannia pumila	None	466
Leiocolea turbinata	None	466
Lophozia incisa	Fungal association (B)	328
Lophozia sudetica	Fungal association (B)	328
Lophozia ventricosa	Fungal association (B)	182
Mylia anomala	Fungal association	328, 466
Mylia taylorii	Fungal association	328
Nardia breidleri	Fungal association	466
Nardia scalaris	Fungal association (B)	182, 328
Sphenolobus helleranus	None	466

Examined species[a]	Mycorrhizal status[b,c]	References
Sphenolobus minutus	None	466
Gymnomitriaceae		
Gymnomitrion concinnatum	None	466
Gymnomitrion crenulatum	None	466
Gymnomitrion obtusum	None	466
Marsupella adusta	None	466
Marsupella alpina	None	466
Marsupella emarginata	None	466
	Fungal association	328
Marsupella stableri	None	466
Anthocerotaceae		
Anthoceros punctatus	AM-like	525
Phaeoceros laevis	AM-like	344
PTERIDOPHYTES		
Lycopodiaceae		
Diphasiastrum alpinum	AM + NM	260, 261
Diphasiastrum complanatum	NM	654
Diphasiastrum issleri	AM	260, 261
Huperzia australiana	AM	342
Huperzia phyllantha	AM	226
Huperzia selago	AM + NM	260, 261
Huperzia serrata f. longipetiolata	NM	654
Lycopodiastrum casuarinoides	NM	654
Lycopodiella inundata	AM	212
	AM + NM	260, 261
Lycopodium alpinum	NM	594
Lycopodium annotinum	AM	260, 261
Lycopodium cernuum	AM	181, 226
Lycopodium clavatum	AM	521, 594
	AM + NM	260, 261
Lycopodium japonicum	AM	654
Lycopodium selago	NM	594
Palhinhaea cernua	NM	654
Phlegmariurus henryi	NM	654
Isoetaceae		
Isoetes echinospora	NM	260, 261
Isoetes histrix	NM	260, 261
Isoetes lacustris	NM	260, 261
Selaginellaceae		
Selaginella arbuscula	AM	226
Selaginella biformis	AM	654
Selaginella chrysocaulos	NM	654
Selaginella davidii	AM	653, 654
Selaginella delicatula	AM	654
Selaginella frondosa	AM	654
Selaginella helferi	NM	654
Selaginella involvens	AM	654
Selaginella kraussiana	AM + NM	260, 261
Selaginella mairei	AM	343
Selaginella moellendorfii	AM	653
Selaginella monospora	NM	654
Selaginella picta	AM	654
Selaginella pulvinata	AM	343, 654
Selaginella remotifolia	AM	654
Selaginella sanguinolenta	AM	654
Selaginella selaginoides	AM	260, 261
Equisetaceae		
Equisetum arvense	NM	307, 594, 260, 261
	AM	599
Equisetum debile	NM	654
Equisetum diffusum	AM	343
	NM	654
Equisetum fluviatile	NM	260, 261
Equisetum hyemale	AM	653, 260, 261
Equisetum palustre	NM	260, 261
Equisetum pratense	NM	260, 261
Equisetum ramosissimum	NM	368, 260, 261
	AM	653
Equisetum sylvaticum	AM + NM	260, 261
Equisetum telmateia	AM	260, 261
Equisetum× trachydon	AM	260, 261
Equisetum variegatum	NM	594
	AM	260, 261
Marattiaceae		
Angiopteris caudatiformis	AM	654, 655
Angiopteris evecta	AM	226
Angiopteris hokouensis	AM	654
Angiopteris wangii	AM	654
Angiopteris yunnanensis	AM	654
Archangiopteris bipinnata	AM	654
Archangiopteris henryi	AM	654
Archangiopteris hokouensis	AM	654
Archangiopteris subrotundata	AM	654
Calathea sp.	AM	510
Christensenia assamica	AM	654
Ctenanthe sp.	AM	510
Ischnosiphon gracilis	AM	510
Marattia douglasii	NM	226
Monotagma plurispicatum	AM	510
Saranthe compositae	NM	510
Stromanthe porteana	AM	510
Psilotaceae		
Psilotum complanatum	NM	226
Psilotum nudum	AM	226
Psilotum sp.	AM	483
Ophioglossaceae		
Botrychium lanuginosum	AM	653
Botrychium lunaria	AM	194, 260, 261
Botrychium ternatum	AM	653
Botrychium virginianum	AM	329

Examined species[a]	Mycorrhizal status[b,c]	References
Ophioglossum concinnum	AM	226
Ophioglossum lusitanicum	AM	260, 261
Ophioglossum pendulum	AM	226
Ophioglossum petiolatum	AM	654
	NM	226
Ophioglossum reticulatum	AM	522, 654
Ophioglossum themale	AM	654
Ophioglossum vulgatum	AM	653, 260, 261
Osmundaceae		
Osmunda cinnamomea	AM	140
Osmunda japonica	AM	653, 654
Osmunda regalis	AM + NM	260, 261
Hymenophyllaceae		
Crepidomanes latealatum	NM	654
Hymenophyllum tunbrigense	M (endo)	260, 261
Hymenophyllum wilsonii	M (endo)	260, 261
Mecodium badium	NM	654
Mecodium blumeanum	NM	654
Mecodium recurvum	AM	226
Sphaerocionium lanceolatum	AM	226
Trichomanes auriculatum	NM	654
Trichomanes speciosum	NM	260, 261
Vandenboscia cyrtotheca	NM	226
Vandenboscia davalliodes	NM	226
Gleicheniaceae		
Dicranopteris dichotoma	AM	653
Dicranopteris gigantea	NM	654
Dicranopteris linearis	AM	226
Dicranopteris pedata	NM	654
Dicranopteris splendida	NM	654
Diplopterygium glaucoides	NM	654
Diplopterygium glaucum	NM	654
Diplopterygium pinnatum	AM	226
Sticherus laevigatus	NM	654
Sticherus owhyhensis	AM	226
Schizaeaceae		
Anemia phyllitidis	AM	31
Lygodium conforme	AM	654
Lygodium japonicum	AM	653
	NM	654
Schizaea robusta	AM	226
Marsileaceae		
Pilularia globulifera	AM + NM	260, 261
Azollaceae		
Azolla filiculoides	NM	226, 260, 261
Plagiogyriaceae		
Plagiogyria distinctissima	AM	654
Cyatheaceae		
Alsophila constularis	NM	654
Alsophila spinulosa	AM	654
Cyathea cooperi	AM	226

Examined species[a]	Mycorrhizal status[b,c]	References
Gymnosphaera gigantea	NM	654
Gymnosphaera podophylla	NM	654
Sphaeropteris brunoniana	NM	654
Dicksoniaceae		
Cibotium barometze	NM	654
Cibotium chamissoi	AM	226
Cibotium glaucum	AM	226
Cibotium st.-johnii	AM	226
Pteridaceae		
Doryopteris decipiens	AM	226
Doryopteris decora	AM	226
Histiopteris incisa	AM	654
Pellaea mairei	AM	654
Pellaea ternifolia	AM	226
Pteridium aquilinum	AM	653
Pteridium revolutum	NM	654
Pteris aspericaulis	AM	653
Pteris aspericaulis var. tricolor	NM	654
Pteris cretica	AM	226
Pteris cretica var. laeta	NM	654
Pteris cretica var. nervosa	NM	654
Pteris dissitifolia	NM	654
Pteris ensiformis	NM	654
Pteris esquirolii	NM	654
Pteris excelsa	AM	226
	NM	654
Pteris irregularis	AM	226
Pteris linearis	NM	654
Pteris semipinnata	NM	654
Pteris setulosocostulata	AM	654
Pteris venusta	AM	655
Pteris vittata	AM	226, 653
	NM	654
Pteris wangiana	NM	654
Vittariaceae		
Antrophyrum henryi	NM	654
Vittaria elongata	AM	226
Vittaria flexuosa	NM	654
Adiantaceae		
Adiantum bonatianum	AM	654
Adiantum capillus-veneris	AM + NM	260, 261
Adiantum edgewothii	AM	654
Adiantum flabellulatum	AM	654
Adiantum malesianum	NM	654
Adiantum philipense	AM	343
	NM	654
Aleuritopteris albomarginatata	AM	654
Aleuritopteris argentea	AM	654
Aleuritopteris duclouxii	NM	654
Aleuritopteris pseudofarinosa	NM	654

Examined species[a]	Mycorrhizal status[b,c]	References
Anogramma leptophylla	NM	260, 261
Cheilosoria hancockii	AM	654
Coniogramme intermedia	AM	654
Coniogramme rosthorni	NM	654
Coniogramme simillima	AM	654
Cryptogramma crispa	AM + NM	260, 261
Gymnopteris bipinnata var. auriculata	NM	654
Gymnopteris vestita	AM	654
Leptolepidium subvillosum	NM	654
Onychium angustifrons	NM	654
Onychium contigium	AM	654
Onychium japonicum var. lucidum	NM	654
Onychium lucidum	AM	654
Sinopteris grevilleoides	NM	654
Dennstaedtiaceae		
Dennstaedtia melanostipes	AM	654
Dennstaedtia scabra	AM	654
Hypolepis punctata	NM	654
Lindsaea cultrata	AM	653
Lindsaea ensifolia	NM	654
Lindsaea javanensis	NM	654
Lindsaea odorata	NM	654
Lindsaea orbiculata	AM	654
Microlepia hookeriana	AM	654
Microlepia marginata	AM	654
Microlepia marginata var. calvescens	AM	654
Microlepia pilosissima	AM	654
Microlepia platyphylla	NM	654
Microlepia rhomboidea	NM	654
Microlepia strigosa	AM	226
Monachosorum henryi	AM	654
Pteridium aquilinum	AM + NM	260, 261
Pteridium decompositum	AM	226
Schizoloma heterophyllum	NM	653
Stenoloma chusanum	AM	653, 654
Aspleniaceae		
Acrophorus stipellatus	NM	654
Acystopteris tenuisecta	AM	654
Allantodia alata	NM	654
Allantodia chinensis	AM	653
Allantodia dilatata	AM	654
Allantodia doederleinii	NM	654
Allantodia laxifrons	AM	654
Allantodia megaphylla	NM	654
Allantodia spectabilis	AM	654
Allantodia stenochlamys	NM	654
Asplenium adiantum-	AM	226
nigrum	AM + NM	260, 261
Asplenium billotii	NM	260, 261
Asplenium cheilosorum	AM	654

Examined species[a]	Mycorrhizal status[b,c]	References
Asplenium excisum	NM	654
Asplenium finlaysonianum	NM	654
Asplenium florentinum	AM	226
Asplenium fuscipes	NM	654
Asplenium griffithianum	NM	654
Asplenium horridum	NM	226
Asplenium lushanense	AM	654
Asplenium macraei	AM	226
Asplenium marinum	NM	260, 261
Asplenium nidus	NM	226
Asplenium normale	AM	226
	NM	654
Asplenium onopteris	NM	472
Asplenium pekinense	NM	654
Asplenium praemosum	NM	654
Asplenium prolongatum	NM	654
Asplenium ruta-muraria	AM + NM	260, 261
Asplenium septentrionale	NM	260, 261
Asplenium sphenotomum	AM	226
Asplenium tenuicaule	NM	654
Asplenium trichomanes	AM + NM	260, 261
Asplenium unilaterale	AM	226
	NM	654
Asplenium varians	NM	654
Asplenium viride	AM + NM	260, 261
Asplenium wrightioides	NM	654
Asplenium yunnanense	NM	654
Athyriopsis longipes	AM	654
Athyriopsis ptersennii	AM	654
Athyrium anisopterum	NM	654
Athyrium biserrulatum	AM	654
Athyrium delicatulum	NM	654
Athyrium dissitifolium	AM	654
Athyrium distentifolium	AM + NM	260, 261
Athyrium esculentum	AM	226
Athyrium filix-femina	AM + NM	260, 261
Athyrium japonica	AM	226
Athyrium mackinnonii	NM	654
Athyrium macraei	AM	226
Athyrium mengtzeense	AM	654
Athyrium microphyllum	AM	226
Athyrium niponicum	NM	654
Athyrium sandwichianum	AM	226
Athyrium stigillosum	AM	654
Athyrium wardii	AM	653
Bolbitis heteroclita	NM	654
Bolbitis hokouensis	NM	654
Callipteris esculenta	AM	653
	NM	654
Ceterach officinarum	NM	260, 261
Ctenitis mariformis	AM	653
Ctenitis membranifolia	NM	654
Ctenitopsis devexa	NM	654

Examined species[a]	Mycorrhizal status[b,c]	References
Ctenitopsis glabra	NM	654
Ctenitopsis sagenioides	NM	654
Ctenitopsis setulaosa	NM	654
Ctenitopsis subsageriacea	NM	654
Cystopteris fragilis	AM + NM	260, 261
Cystopteris montana	NM	260, 261
Cystopteris pellucida	AM	653
Diacalpe christensenae	NM	654
Diplazium donianum	AM	653
	NM	654
Diplazium lanceum	AM	653
Diplazium splendens	AM	654
Dryoathyrium boryanum	NM	654
Dryoathyrium edentulum	AM	654
Egenolfia sinensis	AM	654
Egenolfia tokinensis	AM	654
Gymnocarpium dryopteris	AM + NM	260, 261
Hypodematium crenatum	AM	654
Lomariopsis spectabilis	NM	654
Lunathyrium dolosum	NM	654
Monomelangium pullingeri var. daweishannicolum	AM	654
Neottopteris antrophyoides	NM	654
Neottopteris simonsiana	NM	654
Phyllitis scolopendrium	AM	260, 261
Pleocnemia winitei	NM	654
Pseudocystopteris atkinsonii	NM	654
Quercifilix zeylanica	NM	654
Tectaria coadunata	NM	654
Tectaria decurrens	NM	654
Tectaria dubia	NM	654
Tectaria hainanensis	NM	654
Tectaria hokouensis	NM	654
Tectaria simonii	NM	654
Tectaria variolosa	NM	654
Tectaria yunnanensis	NM	654
Woodsia alpina	NM	260, 261
Woodsia ilvensis	NM	260, 261
Thelypteridaceae		
Ampelopteris prolifera	NM	654
Dictyocline wilfordii	AM	653
Cyclogramma auriculata	AM	654
Cyclosorus acuminatus	NM	654
Cyclosorus dentatus	NM	654
Cyclosorus hokouensis	AM	654
Cyclosorus mollicesculus	NM	654
Cyclosorus parasiticus	NM	654
Cyclosorus subnigrescens	NM	654
Cyclosorus truncatus	NM	654
Dictyocline griffithii	AM	654
Glaphylopteridopsis erubescens	AM	654

Examined species[a]	Mycorrhizal status[b,c]	References
Macrothelypteris toressiana	AM	654
Metathelypteris flaccida	NM	654
Oreopteris limbosperma	AM	260, 261
Parathelypteris beddomei	NM	654
Parathelypteris hirsutipes	AM	654
Parathelypteris nipponica	NM	653
Phegopteris connectilis	AM + NM	260, 261
Pronephrium gymnopteridifrons	NM	654
Pronephrium nudotum	NM	654
Pronephrium simplex	NM	654
Pseudocyclosorus esquirolii	AM	654
Pseudocyclosorus subochthodes	NM	654
Pseudophegopteris pyrrhorachis	NM	654
Pseudophegopteris yunkweiensis	NM	654
Thelypteris cyatheoides	NM	226
Thelypteris globulifera	AM	226
Thelypteris hudsoniana	AM	226
Thelypteris interrupta	NM	226
Thelypteris parasitica	AM	226
Thelypteris sandwicensis	NM	226
Thelypteris thelypteroides	AM + NM	260, 261
Blechnaceae		
Blechnum occidentale	AM	226
Blechnum orientale	AM	654
Blechnum penna-marina	NM	342
Blechnum spicant	AM + NM	260, 261
Brainea insignis	NM	654
Doodia kunthiana	AM	226
Sadleria cyatheoides	AM	226
Sadleria squarrosa	AM	226
Woodwardia japonica	AM	654
Woodwardia orientalis	AM	653
Woodwardia unigemmata	NM	654
Dryopteridaceae		
Acrorumohra diffraeta	AM	654
Arachniodes festina	AM	653
Arachniodes globisora	AM	654
Arachniodes rhomboidea	AM	653
Arachniodes simplicior	AM	653
Arachniodes sporadosora	NM	654
Cyrtomium caryotideum f. caryotideum	AM	654
Cyrtomium fortunei	NM	654
Dryopteris basisora	NM	654
Dryopteris caroli-hopei	NM	654
Dryopteris carthusiana	AM	598
	AM + NM	260, 261
Dryopteris chrysocoma	NM	654

Examined species[a]	Mycorrhizal status[b,c]	References
Dryopteris cochleata	NM	654
Dryopteris cristata	AM	260, 261
Dryopteris dilatata	AM	260, 261
Dryopteris filix-mas	AM + ECM + NM	260, 261
Dryopteris fructuosa	AM	654
Dryopteris fuscipes	AM	653
Dryopteris fusco-atra	AM	226
Dryopteris glabra	AM	226
Dryopteris lepidopoda	NM	654
Dryopteris marginata	AM	654
Dryopteris odontoloma	NM	654
Dryopteris sparsa	AM	654
Dryopteris stenolepis	NM	654
Dryopteris sublacera	AM	654
Dryopteris thelypteris	AM	140
Dryopteris unidentata	AM	226
Dryopteris wallichiana	AM	226
Nothoperanema hendersonii	NM	654
Polystichum aculeatum	AM + NM	260, 261
Polystichum alteruatum	NM	654
Polystichum chingae	NM	654
Polystichum dielsii	NM	654
Polystichum eximium	NM	654
Polystichum jizhushanense	AM	654
Polystichum lonchitis	AM	260, 261
Polystichum pycnopterum	NM	654
Polystichum tsus-simense	AM	654
Polystichum vestitum	NM	342
Tectaria gaudichaudii	AM	226
Nephrolepidaceae		
Arthropteris palisotii	NM	654
Nephrolepis biserrata	AM	35
Nephrolepis faleata	NM	654
Polypodiaceae		
Arthromeris mairei	NM	654
Cheilanthes lanosa	AM	449
Colysis diversifolia	NM	654
Colysis hemitoma	NM	653
Colysis hokouensis	NM	654
Colysis pentaphylla	NM	654
Drynaria propinqua	NM	654
Lepidogrammitis rostrama	NM	654
Lepisorus contortus	NM	654
Lepisorus macrosphaerus	NM	654
Lepisorus scolopendrium	NM	654
Microsorium carinatum	NM	654
Microsorium henryi	NM	654
Microsorium membranaceum	NM	654
Microsorium punctatum	NM	654
Microsorium spectrum	NM	226
Neocheiropteris palmatopedata	NM	654
Neolepisorus ovatus	NM	654
Neolepisorus sinensis	NM	654
Onoclea sensibilis	AM	140
Phlebodium aureum	NM	226
Phymatopsis crenatopinnata	NM	654
Phymatopsis nigrovenia	NM	654
Phymatopsis trisecta	NM	654
Phymatosorus scolopendria	NM	226
Pleopeltis thunbergiana	NM	226
Polypodiodes amoenum	NM	654
Polypodium pellucidum	NM	226
Polypodium vulgare	AM + NM	260, 261
Pyrrosia adnaseens	NM	654
Pyrrosia gralla	NM	654
Pyrrosia lingua	NM	654
Pyrrosia mollis	NM	654
Pyrrosia subfurfuracea	NM	654
Pyrrosia tonkinensis	NM	654
Tricholepidium maculosum	NM	654
Grammitidaceae		
Adenophorus abietinus	AM	226
Adenophorus pinnatifidus	NM	226
Adenophorus tamariscinus	AM	226
Grammitis baldwinii	NM	226
Grammitis poeppigeana	NM	342
Grammitis tenella	AM	226
Loxogramme ensiformis	NM	654
Xiphopteris saffordii	NM	226
Davalliaceae		
Araiostegia perdurans	NM	654
Nephrolepis cordifolia	AM	226
Nephrolepis exaltata	AM	226
Nephrolepis multiflora	AM	226
GYMNOSPERMS		
Cycadaceae		
Cycas circinalis	AM	423
Cycas revoluta	AM	423
Zamiaceae		
Ceratozamia mexicana	AM	616
Dioon edule	AM	203, 616
Lepidozamia hopei	AM	484
Macrozamia reidlei	AM	93
Zamia pumila	AM	203
Ginkgoaceae		
Ginkgo biloba	AM	206
Pinaceae		
Abies alba	ECM	189
Abies grandis	ECM	375
Abies lasiocarpa	ECM	314
Abies spp.	ECM	260, 261
Cedrus atlantica	ECM	431

Examined species[a]	Mycorrhizal status[b,c]	References
Larix decidua	ECM	260, 261
Larix kaempferi	ECM	644, 260, 261
Larix occidentalis	ECM	156
Picea abies	ECM	8
	ECM + EEM	260, 261
Picea engelmannii	ECM	314
Picea glauca	ECM	285, 338, 414, 470
Picea glehnii	ECM	308
Picea mariana	ECM	91
Picea rubens	ECM	232
Picea sitchensis	ECM	13, 205, 260, 261
Pinus banksiana	ECM	91
Pinus cembra	ECM	498
Pinus contorta	ECM	98, 156, 403
Pinus densiflora	ECM	228, 309, 634, 635
Pinus echinata	ECM	444
Pinus edulis	ECM	223, 265, 470
Pinus elliottii	ECM	470, 564
Pinus halepensis	ECM	411, 590
Pinus jeffreyi	ECM	617
Pinus lambertiana	ECM	617
Pinus massoniana	ECM	323, 564
Pinus montezumae	ECM	509
Pinus muricata	ECM	218, 280
	ECM + AM	281
Pinus nigra	ECM	260, 261
Pinus patula	ECM	487
Pinus pinaster	ECM	458, 260, 261
Pinus pinea	ECM	368, 451
Pinus ponderosa	AM	550
	ECM	156, 188, 375, 506, 618
Pinus radiata	ECM	184
Pinus resinosa	ECM	363, 470
Pinus rigida	ECM	152
Pinus sylvestris	ECM	239, 320, 420
	ECM + EEM + NM	260, 261
Pinus tabulaeformis	ECM	634, 635
Pinus taeda	ECM	139, 160, 190
Pinus thunbergii	ECM	364
Pseudotsuga menziesii	ECM	70, 156, 236, 259, 280, 375
	AM	550
	AM + ECM	116
	ECM + EEM	260, 261
Tsuga heterophylla	ECM	9, 313
	AM + ECM	116
Ephedraceae		
Ephedra trifurca	AM	137
Welwitschiaceae		
Welwitschia mirabilis	AM	296
Gnetaceae		
Gnetum africanum	ECM	445
Gnetum buchholzianum	ECM	445
Gnetum sp.	AM + ECM	445
Araucariaceae		
Agathis robusta	AM	388
Araucaria angustifolia	AM	31, 89, 650
Araucaria cunninghamii	AM	388
Wollemia nobilis	AM + EEM	388
Wollemia sp.	ECM	656
Podocarpaceae		
Dacrycarpus dacrydioidies	AM	504
Dacrydium cupressinum	AM	504
Parasitaxus ustus	Mycoheterotrophy via AM?	659
Podocarpus falcatus	AM	637, 638
Prumnopitys ferruginea	AM	504
Prumnopitys taxifolia	AM	504
Taxodiaceae		
Metasequoia glyptostroboides	AM	559
Sequoia sempervirens	AM	6
Sequoiadendrom giganteum	AM	6
Cupressaceae		
Austrocedrus chilensis	AM	207
Chamaecyparis thyoides	AM	106
Juniperus communis	AM + ECM	260, 261
Juniperus communis ssp. nana	AM + ECM	260, 261
Juniperus monosperma	AM	470
Juniperus oxycedrusL. ssp. macrocarpa	AM	368
Juniperus procera	AM	637, 638
Libocedrous decurrens	AM	6, 25
Tetraclinis articulata	AM	169, 412
Thuja occidentalis	AM	81, 385
Thuja plicata	AM	100
Taxaceae		
Taxus baccata	AM	637, 638, 260, 261
Taxus × media	AM	515
ANGIOSPERMS		
Nymphaeaceae		
Nuphar × intermedia	NM	260, 261
Nuphar lutea	NM	62, 260, 261
Nuphar pumila	NM	260, 261
Nymphaea alba	NM	260, 261

Examined species[a]	Mycorrhizal status[b,c]	References
Nymphaea sp.	AM	656
Acoraceae		
Acorus calamus	AM	531
	NM	260, 261
Tofieldiaceae		
Tofieldia pusilla	AM	260, 261
Araceae		
Aglaonema modestum	AM	655
Alocasia longiloba	AM	655
Alocasis macrorrhiza	AM	422
Amorphophallus bannaensis	AM	422
Anthurium affine	AM	510
Anthurium pentaphyllum	AM	510
Anthurium pitteri	AM	474
Arum italicum	AM	260, 261
Arum maculatum	AM	260, 261
Arum neglectum	AM	260, 261
Caladium bicolor	AM	510
Calla palustris	NM	260, 261
Colacasia esculenta	AM	531
Dieffenbachia amoena	AM	510
Philodendron ornatum	NM	510
Philodendron undulatum	NM	510
Pistia stratiotes	NM	510
Rhaphidophora decursiva	AM	422
Hydrocharitaceae		
Egreria densa	NM	510
Elodea canadensis	NM	62, 260, 261
Hydrilla verticillata	NM	260, 261
Vallisneria americana	AM	631, 632
Butomaceae		
Butomus umbellatus	NM	260, 261
Alismataceae		
Alisma lanceolatum	AM + NM	260, 261
Alisma plantago-aquatica	AM	58
	NM	62, 260, 261
Alisma subcordatum	Weak AM	626
Alisma triviale	AM	140
Baldellia ranunculoides	AM	368
Echinodorus grandiflorus	NM	510
Sagitaria latifolia	AM	626
Limnocharitaceae		
Hydrocleys nymphoides		
Juncaginaceae		
Triglochin maritima	AM + NM	260, 261
Triglochin palustris	NM	260, 261
Potamogetonaceae		
Potamogeton crispus	NM	62, 260, 261
Potamogeton gramineus	NM	62
Potamogeton lucens	NM	62
Potamageton natans	AM	58
	NM	62, 260, 261
Potamogeton perfoliatus	NM	62
Potamogeton polygonifolius	NM	260, 261
Potamogeton praelongus	NM	62
Petrosaviaceae		
Petrosavia sakuraii	Mycoheterotrophy	657, 658
Petrosavia stellaris	Mycoheterotrophy	657, 658
Nartheciaceae		
Narthecium ossifragum	AM + NM	260, 261
Burmanniaceae		
Burmannia tenella	Mycoheterotrophy (via AM)	290
Thismia sp.	Mycoheterotrophy	656
Dioscoreaceae		
Tacca chantrieri	NM	655
Tamus communis	AM	260, 261
Triuridaceae		
Sciaphila polygyna	Mycoheterotrophy	291
Sciaphila tosaensis	Mycoheterotrophy (via AM)	642
Pandanaceae		
Freycinetia arborea	AM	326
Pandanus furcatus	NM	655
Pandanus tectorius	NM	326
Cyclanthaceae		
Asplundia gardneri	NM	510
Corsiaceae		
Arachnitis uniflora	Mycoheterotrophy (via AM)	79
Alstroemeriaceae		
Alstroemeria aurea	AM	207
Colchicaceae		
Colchicum autumnale	AM	260, 261
Melanthiaceae		
Paris quadrifolia	AM + NM	260, 261
Trillium flexipes	AM	165
Veratrum viride	AM	140
Smilacaceae		
Smilax aspera	AM	63, 368
Smilax corbularia	AM	422
Smilax hypoglauca	AM	422
Smilax indica	AM	422
Liliaceae		
Gagea lutea	AM + NM	260, 261
Lilium martagon	AM	260, 261
Muscari comosum	AM	260, 261
Muscari neglectum	AM	260, 261
Smilacina racemosa	AM	165
Orchidaceae		
Aceras anthropophorum	ORM	260, 261
Anacamptis pyramidalis	ORM	260, 261
Anoectochilus burmannicus	ORM	422
Anoectochilus roxburghii	ORM	422

Examined species[a]	Mycorrhizal status[b,c]	References
Anoectochilus tortus	AM	655
Apostasia odorata	AM	422
Arundina graminifolia	ORM	326
Caladenia formosa	ORM	286
Calypso bulbosa	ORM	153
Cephalanthera austinae	Mycoheterotrophy (via ECM)	569
Cephalanthera damasonium	ORM + ECM	78
	ORM	260, 261
Cephalanthera longifolia	ORM	260, 261
Cephalanthera rubra	ORM + ECM	78
	ORM	368, 260, 261
Chloraea virescens	ORM	207
Coeloglossum viride	ORM	260, 261
Corallorhiza maculata	Mycoheterotrophy (via ECM)	569, 570, 571
Corallorhiza mertensiana	Mycoheterotrophy	570
Corallorhiza trifida	Mycoheterotrophy	392, 260, 261
Corybas dienemus	ORM	342
Cypripedium calceolus	ORM	540
	ORM + NM	260, 261
Cypripedium californicum	ORM	540
Cypripedium candidum	ORM	540
Cypripedium fasciculatum	ORM	540
Cypripedium guttatum	ORM	540
Cypripedium montanum	ORM	540
Cypripedium parviflorum	ORM	540
Dactylorhiza fuchsia	ORM	260, 261
Dactylorhiza incarnara	ORM	173, 260, 261
Dactylorhiza maculata	ORM	260, 261
Dactylorhiza maculata ssp. ericetorum	ORM	260, 261
Dactylorhiza majalis	ORM	78, 334, 480, 260, 261
Dactylorhiza praetermissa	ORM	260, 261
Dactylorhiza praetermissa var. junialis	ORM	173
Dactylorhiza purpurella	ORM	260, 261
Epipactis atrorubens	ORM + ECM	78
	ORM	304, 260, 261
Epipactis distans	ORM + ECM	78
Epipactis helleborine	ORM + ECM	78
	ORM	260, 261
Epipactis microphylla	ORM + ECM	530
Epipactis palustris	ORM	78, 481
	ORM + NM	260, 261
Epipactis purpurata	ORM	260, 261
Epipogium aphyllum	ORM	260, 261
Goodyera repens	ORM	260, 261
Gymnadenia conopsea	ORM	260, 261
Gymnadenia odoratissima	ORM	260, 261
Haemaria discolor var. dawsoniana	ORM	122
Hammarbya paludosa	ORM	260, 261
Herminium monorchis	ORM	260, 261
Hexalectris spicata	Mycoheterotrophy (via ECM)	572
Himantoglossum hircinum	ORM	260, 261
Ionopsis utricularioides	ORM	448
Liparis loeselii	ORM	260, 261
Listera cordata	ORM	260, 261
Listera ovata	ORM	260, 261
Malaxis latifolia	ORM	422
Microtis parviflora	ORM	459
Neotinea maculata	ORM	260, 261
Neottia nidus-avis	ORM + ECM	78
	ORM	260, 261
Newiedia veratrifolia	ORM	333
Ophrys apifera	ORM	260, 261
Ophrys fuciflora	ORM	260, 261
Ophrys insectifera	ORM	260, 261
Ophrys lutea	ORM	56
Ophrys sphegodes	ORM	260, 261
Orchis mascula	ORM	260, 261
Orchis militaris	ORM	260, 261
Orchis morio	ORM	75, 173, 260, 261
Orchis palustris	ORM	195
Orchis purpurea	ORM	260, 261
Orchis simia	ORM	260, 261
Orchis ustulata	ORM	260, 261
Phaius mishmensis	AM	655
Platanthera bifolia	ORM	260, 261
Platanthera chlorantha	ORM	78, 260, 261
Platanthera leucophaea	ORM	652
Pseudorchis albida	ORM	260, 261
Pterostylis acuminata	ORM	460
Serapias vomeracea ssp. vomeracea	ORM	195
Spathoglottis plicata	ORM	326, 534, 565
Spiranthes aestivalis	ORM	260, 261
Spiranthes sinensis var. amoena	ORM	376
Spiranthes spiralis	ORM	368, 260, 261
Stanhopea tigrina	ORM	196
Tolumnia variegata	ORM	448
Asteliaceae		
Astelia menziesiana	AM	326
Hypoxidaceae		
Curculigo capitulata	AM	422
Iridaceae		
Crocus vernus	AM	260, 261
Gladiolus segetum	AM	260, 261
Iris foetidissima	AM	260, 261
Iris germanica	AM	260, 261

Examined species[a]	Mycorrhizal status[b,c]	References
Iris pseudacorus	AM	368
	AM + NM	260, 261
Sisyrinchium atlanticum	AM	643
Sisyrinchium sp.	NM	207
Sparaxis tricolor	AM	514
Hemerocallidaceae		
Dianella sandwicensis	AM	326
Asphodelaceae		
Asphodelus fistulosus	AM	114, 115
Bulbine alata	AM	438
Haworthia tortuosa	AM	417
Alliaceae		
Allium ampeloprasum	AM	260, 261
Allium canadense	AM	140
Allium cepa	AM	7, 349, 260, 261
Allium oleraceum	AM + NM	260, 261
Allium porrum	AM	272, 260, 261
Allium sativum	AM	260, 261
Allium schoenoprasum	AM	3, 260, 261
Allium scorodoprasum	AM	260, 261
Allium sphaerocephalon	AM	472, 260, 261
Allium subhirsutum	AM	472
Allium triquetrum	AM	260, 261
Allium ursinum	AM	260, 261
Amaryllidaceae		
Galanthus nivalis	AM	260, 261
Leucojum aestivum	AM	260, 261
Leucojum vernum	AM + NM	260, 261
Narcissus poeticus	AM	260, 261
Narcissus pseudonarcissus	AM	260, 261
Themidaceae		
Brodiaea laxa	AM	513
Hyacinthaceae		
Hyacinthoides non-scripta	AM	398, 399, 260, 261
Ornithogalum nutans	AM	260, 261
Ornithogalum pyrenaicum	AM	260, 261
Ornithogalum umbellatum	AM	260, 261
Scilla autumnalis	AM	260, 261
Agavaceae		
Agave americana	AM	343
Agave datylio	Weak AM	112
Agave deserti	AM	151
Agave marmorata	AM	103
Agave salmiana	Weak AM	103
Agave univittata	AM	417
Yucca elata	AM	137
Yucca periculosa	Weak AM	103
Yucca valida	AM	417
Asparagaceae		
Asparagus acutifolius	AM	368, 472
Asparagus officinalis	AM	192, 383, 260, 261
Ruscaceae		
Convallaria majalis	AM + NM	260, 261
Maianthemum bifolium	AM + NM	260, 261
Polygonatum multiflorum	AM + NM	260, 261
Polygonatum odoratum	AM + NM	260, 261
Polygonatum verticillatum	AM + NM	260, 261
Ruscus aculeatus	AM	368, 260, 261
Arecaceae		
Astrocaryum mexicanum	AM	436
Bactris gasipaes	AM	135
Caryota monostachya	AM	655
Cocos nucifera	AM	326, 580
Euterpe edulis	AM	651
Euterpe oleracea	AM	130
Serenoa repens	AM	201
Syagrus romanzoffiana	Weak AM	651
Wallichia mooreana	NM	655
Sparganiaceae		
Sparganium angustifolium	NM	62
Sparganium chlorocarpum	AM	58
Sparganium emersum	NM	62
Sparganium erectum	NM	62
	AM	260, 261
Sparganium eurycarpum	Weak AM	626
Typhaceae		
Typha angustifolia	NM	62, 368
	Weak AM	557
	AM	566, 260, 261
Typha latifolia	NM	62
	Weak AM	557
	AM	140, 185, 599
Typha × glauca	Weak AM	557
Bromeliaceae		
Aechmea stelligera	NM	510
Ananas comosus	AM	44, 246
Hechtia aff. podantha	Weak AM	103
Vriesea limae	AM	510
Juncaceae		
Juncus acutiflorus	AM + NM	260, 261
Juncus alpinus	AM + NM	260, 261
Juncus articulatus	AM	260, 261
Juncus biglumis	NM	260, 261
Juncus bufonius	AM + NM	260, 261
Juncus bulbosus	NM	62, 260, 261
Juncus dudleyi	AM	599
Juncus effuses	NM	62
	AM	140
	AM + NM	260, 261
Juncus filiformis	Weak AM	194
	NM	260, 261
Juncus gerardi	AM + NM	260, 261

Examined species[a]	Mycorrhizal status[b,c]	References
Juncus inflexus	AM	260, 261
Juncus maritimus	NM	368, 260, 261
Juncus nodosus	AM	599
Juncus planifolius	AM	326
Juncus roemerianus	AM	278
Juncus scheuchzerioides	AM	342
	NM	560
Juncus squarrosus	AM + NM	260, 261
Juncus torreyi	AM	599
Juncus trifidus	AM	260, 261
Luzula campestris	AM + NM	260, 261
Luzula crinita var. crinita	NM	342
Luzula hawaiiensis	AM	326
Luzula luzuloides	NM	260, 261
Luzula pallescens	NM	260, 261
Luzula pilosa	AM + NM	260, 261
Luzula spicata	AM	260, 261
Luzula sylvatica	NM	260, 261
Cyperaceae		
Bequerelia cymosa	AM	426
Bulboschoneus maritimus	AM	426
Bulbostylis barbata	Facultative AM	426
Bulbostylis capillaris	NM	326
	AM	149
	Facultative AM	426
Bulbostylis cf. conifera	AM	358
Bulbostylis densa	AM	426
Bulbostylis paradoxa	AM	358
Bulbostylis puberula	NM	426
Carex acnescens	NM	426
Carex acuta	NM	62, 260, 261
Carex acutiformis	NM	260, 261
Carex albonigra	NM	426
Carex amphibola	NM	402
Carex annectens	AM	402
Carex aphylla	NM	207
Carex aquatilis	NM	426
Carex arenaria	AM + NM	260, 261
Carex atherodes	NM	402
	Facultative AM	426
Carex baccans	AM	426
Carex bicknellii	AM	402
Carex bigelowii	NM	501, 594, 426
Carex blanda	AM	402
Carex boelckeiana	NM	207
Carex brevior	AM	402
Carex brizoides	NM	426
Carex brunnescens	AM	194
Carex buxbaumii	AM	402
	NM	260, 261
Carex caryophyllea	NM	456, 260, 261
Carex cephalophora	AM	402

Examined species[a]	Mycorrhizal status[b,c]	References
Carex chordorrhiza	NM	260, 261
Carex crawei	AM	402
Carex cristatella	AM	58, 402
Carex curta	NM	260, 261
Carex davalliana	AM	260, 261
Carex digitata	NM	260, 261
Carex dioica	NM	260, 261
Carex distans	NM	260, 261
Carex disticha	AM + NM	260, 261
Carex divulsa	AM	260, 261
Carex ebenea	NM	426
Carex echinata	NM	260, 261
Carex elongata	NM	260, 261
Carex ericetorum	NM	456, 260, 261
Carex fillifolia	NM	426
Carex flacca	NM	426
	AM + NM	260, 261
Carex flava	AM	140
	NM	426
	AM + NM	260, 261
Carex fuscula	AM	426
Carex gayana	NM	426
Carex grannularis	AM	402, 599
Carex gravida	AM	402
Carex hallerana	NM	472
Carex hirta	AM	456
	NM	260, 261
Carex hostiana	NM	260, 261
Carex humilis	NM	260, 261
Carex hystericina	NM	426
Carex interior	NM	402
Carex lachenalii	NM	426, 260, 261
Carex lanuginosa	NM	599
Carex lasiocarpa	AM	58
	Weak AM	626
	Facultative AM	426
	NM	426, 260, 261
Carex lepidocarpa	NM	260, 261
Carex limosa	NM	260, 261
Carex lindleyana	AM	426
Carex lurida	AM	58, 140
Carex madoviana	NM	426
Carex maritime	NM	426
Carex membranacea	NM	426
Carex mertensii	NM	584
Carex meyenii	AM	326
Carex microchaeta	NM	594
Carex misandra	NM	426
Carex montana	NM	260, 261
Carex muricata	NM	426
	AM + NM	260, 261
Carex myosurus	AM	426

Examined species[a]	Mycorrhizal status[b,c]	References
Carex nardina	NM	426
Carex nigra	AM	140, 194
	AM + NM	260, 261
Carex otrubae	NM	260, 261
Carex oxyandra	NM	587
Carex pallescens	AM	194
	NM	260, 261
Carex panacea	AM	194
Carex panicea	AM + NM	260, 261
Carex paniculata	NM	260, 261
Carex pellita	NM	402
Carex pendula	NM	368, 260, 261
Carex pensylvanica	AM	402
Carex pilulifera	NM	260, 261
Carex podocarpa	NM	594
Carex pulicaris	NM	260, 261
Carex remota	AM + NM	260, 261
Carex riparia	NM	260, 261
Carex rosea	AM	402
Carex rostrata	NM	260, 261
Carex scoparia	AM	402
	NM	140
Carex serotina	NM	260, 261
Carex speciosa	AM	426
Carex sprengelii	NM	402
Carex stenophylla ssp. eleocharis	NM	426
Carex sterilis	NM	426
Carex stipata	AM	140, 402
Carex stricta	NM	140, 402
	AM	626
	Facultative AM	426
Carex aff. subantarticata	NM	426
Carex subspathecea	NM	426
Carex sylvatica	NM	426, 260, 261
Carex tenera	NM	402
Carex tetanica	AM	402
Carex tribuloides	AM	58, 140
Carex trichocarpa	AM	599
Carex trifida	NM	342
Carex ursine	NM	426
Carex urticulata	NM	426
Carex vaginata	NM	503, 260, 261
Carex vesicaria	AM	626
	AM + NM	260, 261
Carex vulpina	NM	260, 261
Carex vulpinoidea	AM	58, 140, 402
Carex wahuensis	AM	326
	NM	426
Caustis dioica	NM	426
Caustis flexuosa	AM	67
Cladium amaicense	AM	426
Cladium jamaicense	AM	297
Cladium mariscus	NM	368
	AM + NM	260, 261
Cyathochaeta avenccea	NM	426
Cyperus arenarius	AM	426
Cyperus articulatus	Weak AM	143
	Facultative AM	426
Cyperus brevifolius	AM	426
Cyperus bulbosus	NM	426
Cyperus castaneous	NM	426
Cyperus clarkei	AM	426
Cyperus compressus	Facultative AM	426
Cyperus cyperinus	AM	426
Cyperus decompositus	NM	426
Cyperus difformis	Facultative AM	426
Cyperus distans	Facultative AM	426
Cyperus dubius	AM	426
Cyperus esculentus	NM	426
Cyperus exaltatus	NM	426
Cyperus flavescens	AM	599
Cyperus halpan	Facultative AM	426
	NM	426
Cyperus iria	AM	424, 426
Cyperus javanicus	NM	426
Cyperus kyllinga	Facultative AM	355, 426
Cyperus laevigatus	AM	426
Cyperus ligularis	AM	426
	Facultative AM	426
Cyperus luzulae	NM	426
Cyperus microiria	NM	643
Cyperus niveus	AM	343
Cyperus nutans	AM	426
Cyperus odoratus	AM	426
Cyperus paniceus	AM	426
Cyperus pilosus	AM	426
Cyperus platyphyllus	AM	426
Cyperus pohlii	NM	426
Cyperus pygmaeus	AM	426
Cyperus rotundus	NM	326
	AM	343, 424, 425
	Facultative AM	426
Cyperus squarrosus	AM	426
Cyperus stoloniferous	AM	426
Cyperus strigosus	AM	599
	NM	426
Cyperus surinamensis	Facultative AM	426
Cyperus tenuispica	NM	426
Cyperus triceps	AM	426
Eleocharis acutangula	AM	426
Eleocharis dulcis	AM	426
Eleocharis erythropoda	NM	599
Eleocharis geniculata	AM	426
	NM	426
Eleocharis multicaulis	NM	260, 261

Examined species[a]	Mycorrhizal status[b,c]	References
Eleocharis ovata	AM	140
Eleocharis aff. pachycarpa	NM	426
Eleocharis palustris	NM	62
	AM + NM	260, 261
Eleocharis quinqueflora	NM	260, 261
Eleocharis scheuchezeri	NM	426
Eleocharis tenius	NM	426
Eleocharis triste	NM	426
Eleocharis uniglumis	NM	260, 261
Eleocharis vaginatum	NM	426
Eriophorum angustifolium	AM + NM	260, 261
Eriophorum latifolium	NM	260, 261
Eriophorum vaginatum	AM + NM	260, 261
Fimbristylis consanguinea	AM	426
Fimbristylis cymosa	NM	326, 355
Fimbristylis eragrostis	AM	426
Fimbristylis falcata	Facultative AM	426
Fimbristylis miliacea	Facultative AM	426
Fimbristylis ovata	Facultative AM	426
Fimbristylis schoenoides	NM	426
Fimbristylis trachycarya	NM	426
Fimbristylis triflora	NM	426
Frimbristyllis complanata	NM	149
Fuirena ciliaris	NM	426
Gahnia gahiniformis	NM	426
Gahnia vitiensis	AM	326
Gahnia vitiensis ssp. kauaiensis	AM	326
Hypolytrum bullatum	AM	426
Hypolytrum pulchrum	AM	149, 358
Isolepis antartica	NM	426
Isolepis aucklandica	NM	342
Isolepis nodosa	AM	426
Kobresia bellardii	AM	426
Kobresia myosuroides	Facultative AM	426
	ECM	656
Kobresia simpliciuscula	NM	426, 260, 261
Kyllinga brevifolia	NM	422, 426
Kyllinga bulbosa	NM	426
Kyllinga nemoralis	NM	426
Lagenocarpus guianensis	AM	358
Lagenocarpus sphacelata	NM	426
Lepidosperma gracile	AM	397
Machaerina augustifolia	NM	326
Machaerina mariscoides	AM	326
Mariscus dubius	NM	426
Mariscus mariscoides ssp. meyenii	AM	426
Mariscus meyenianus	AM	326
Mariscus paniceus	NM	426
Mariscus squarrosus	NM	426
Mesomelaena pseudostygia	NM	426
Oreobolus furcatus	AM	326

Examined species[a]	Mycorrhizal status[b,c]	References
Pleurostachys cephalotes	Facultative AM	426
Pycreus flavidus	AM	426
Pycreus polystachyos	Facultative AM	426
	AM	326
Pycreus pumilus	AM	426
Pycreus puncticulatus	NM	426
Rhynchospora barbata	AM	149, 358
Rhynchospora brasiliensis	AM	358
Rhynchospora cephalotes	Facultative AM	426
Rhynchospora ciliata	NM	426
Rhynchospora cormbosa	AM	426
Rhynchospora longisetis	NM	426
Rhynchospora pubera	AM	426
Rikliella squarrosa	AM	426
Schoenoplectus grossus	NM	426
Schoenoplectus juncoides	NM	426
Schoenoplectus senegalensis	NM	426
Schoenoplectus supinus	AM	426
Schoenus ferrugineus	AM + NM	260, 261
Schoenus nigricans	AM + NM	260, 261
Scirpus acutus	AM	58, 626
Scirpus atrovirens	AM	58, 140, 599, 626
Scirpus cespitosus	NM	426
Scirpus cyperinus	AM	58, 140
Scirpus fluviatilis	AM	426
Scirpus holoschoenus	NM	368
Scirpus maritimus	AM	626
	NM	260, 261
Scirpus pendulus	AM	599
Scirpus aff. perpusillus	NM	426
Scirpus pungens	AM	599
Scirpus robustus	AM	426
Scirpus sylvaticus	NM	260, 261
Scirpus tabernaemontani	AM	599
Scirpus validus	AM	58
Scleria latifolia	Facultative AM	426
Scleria lithosperma	AM	426
Scleria melaleuca	Facultative AM	426
Tetraria capillaris	AM	397
Trichophorum alpinum	NM	260, 261
Trichophorum cespitosum	AM + NM	260, 261
Uncinia richleriana	NM	207
Uncinia uncinata	NM	326
Restionaceae		
Alexgeorgea nitens	AM	397
Lyginia barbata	AM	397
Poaceae		
Aeluropus littoralis var. sinensis	AM	620
Agropyron desertorum	AM	183
Agropyron repens	AM	307

Examined species[a]	Mycorrhizal status[b,c]	References
Agropyron smithii	AM	354
Agropyron trachycaulum	AM	132
Agropyron tsukushiense var. pransiens	AM	643
Agropyron tsukushiense var. transiens	AM	294
Agrostis alba	AM	140
Agrostis canina	AM + NM	260, 261
Agrostis capillaris	AM	242
	AM + NM	260, 261
Agrostis gigantea	AM	260, 261
Agrostis magellanica	AM	560
	NM	342
Agrostis palustris	AM	126
Agrostis scabra	AM	95, 587
Agrostis stolonifera	AM	456, 467
	AM + NM	260, 261
Agrostis stolonifera ssp. stolonifera	NM	307
Aira caryophyllea	NM	207
	AM + NM	260, 261
Aira praecox	AM + NM	260, 261
Alopecurus aequalis	NM	260, 261
Alopecurus geniculatus	AM	260, 261
Alopecurus myosuroides	AM	260, 261
Alopecurus pratensis	AM	260, 261
Ammocalamagrostis baltica	AM + NM	260, 261
Ammophila arenaria	AM	331, 368
	AM + NM	260, 261
Ammophila breviligulata	AM	224, 225, 324, 352
Ampelodesmos mauritanicus	AM	472
Andropogon capillipes	AM	415
Andropogon gerardii	Facultative AM	29
	AM	168, 263, 276, 524
Andropogon gerardii var. paucipilus	AM	88
Andropogon virginicus	AM	326, 415
Anthoxanthum odoratum	AM	194
	AM + NM	260, 261
Apera spica-venti	AM	260, 261
Aristida adscensionis	AM	479
Aristida contorta	Weak AM	438
Aristida holathera	NM	438
Aristida longiseta	AM	604
Aristida mutabilis	AM	567
Aristida aff. romeriana	AM	143
Aristida stricta	NM	30, 415
Arrhenatherum elatius	AM + NM	260, 261
Avena barbata	AM	472

Examined species[a]	Mycorrhizal status[b,c]	References
Avena fatua	AM	260, 261
Avena sativa	AM	15
	AM + NM	260, 261
Avena strigosa	AM	260, 261
Avenula pratensis	AM	260, 261
Avenula pubescens	AM	260, 261
Axonopus pruinosus	AM	358
Beckmannia syzigachne	AM	294
Bothriochloa pertusa	AM	343
Bouteloua eripoda	AM	137
Boutelous repens	AM	143
Brachiaria decumbens	AM	150, 358
Brachiaria humidicola	AM	150, 358
Brachypodium pinnatum	AM + NM	260, 261
Brachypodium ramosum	AM	472
Brachypodium sylvaticum	AM	260, 261
Briza maxima	AM	472, 260, 261
Briza media	AM + NM	260, 261
Briza minor	AM	643, 260, 261
Bromus erectus	AM	260, 261
Bromus hordeaceus	AM	493
	AM + NM	260, 261
Bromus inermis	AM	260, 261
Bromus madritensis ssp. rubens	AM	646
Bromus sterilis	NM	260, 261
Bromus tectorum	Facultative AM	237
Calamagrostis canescens	AM	260, 261
Calamagrostis epigejos	AM	307
	AM + NM	260, 261
Calamagrostis stricta	AM	260, 261
Calamagrostis villosa	AM	54, 366, 615
Calamovilfa longifolia	AM	88
Catapodium rigidum	AM	472
Cenchrus ciliaris	AM	20
Cenchrus setigerus	AM	567
Chusquea culeou	AM	207
Cinna arundinacea	AM	140
Corynephorus canescens	AM	81
	AM + NM	260, 261
Cymbopogon jwarancusa	AM	567
Cymbopogon winterianus	AM	327
Cynodon dactylon	AM	294, 260, 261
Cynosurus cristatus	AM	260, 261
Dactylis glomerata	AM	497
	AM + NM	260, 261
Danthonia decumbens	AM	194, 260, 261
Dendrocalamus asper	AM	608
Dendrocalamus strictus	AM	482
Deschampsia antarctica	Facultative AM	166
	NM	560
Deschampsia caespitosa	NM	342

Examined species[a]	Mycorrhizal status[b,c]	References
Deschampsia cespitosa	AM	194, 293, 260, 261
Deschampsia chapmanii	AM	342
Deschampsia flexuosa	AM	194, 270, 366, 615, 260, 261
Desmazeria rigida	AM	260, 261
Dichanthelium cynodon	AM	326
Dichanthelium lanuginosum	AM	95
Digitaria adscendens	AM	294
Digitaria chinensis	AM	422
Digitaria ciliaris	Weak AM	129
	AM	643
Digitaria eriantha	AM	23
Digitaria sanguinalis	AM	260, 261
Digitaria violascens	AM	422
Distichlis spicata	AM	278
Distichlis stricta	AM	302
Echinochloa crus-galli	AM	140
	AM + NM	260, 261
Echinolaena inflexa	AM	358
Eleusine coracana	AM	576
Eleusine indica	AM	422
Elymus canadensis	AM	263, 274
Elymus caninus	AM	260, 261
Elymus farctus	AM + NM	260, 261
Elymus pycnanthus	AM + NM	260, 261
Elymus repens	AM	260, 261
Enneapogon avenaceus	AM	438
Eragrostis dielsii	Facultative AM	438
Eragrostis ferruginea	AM	643
Eriachne aristidea	Weak AM	438
Festuca altissima	NM	260, 261
Festuca argentina	AM	207
Festuca arundinacea	AM	275, 260, 261
Festuca baffinensis	AM	158
Festuca brachyphylla	AM	158
Festuca brigantina	AM	235
Festuca contracta	NM	342
Festuca erecta	AM	560
Festuca gigantea	NM	260, 261
Festuca hyperborea	NM	158
Festuca idahoensis	AM	109, 371
Festuca juncifolia	AM	260, 261
Festuca lemanii	AM	260, 261
Festuca ovina	AM	194, 456
	AM + NM	260, 261
Festuca pallescens	AM	207
Festuca pratensis	AM	194
	AM + NM	260, 261
Festuca pumila	AM	80
Festuca rubra	AM + ECM + NM	260, 261
Festuca vivipara	AM	260, 261
Glyceria fluitans	NM	260, 261
Glyceria maxima	NM	260, 261
Glyceria plicata	AM + NM	260, 261
Heteropogon contortus	AM	326, 343
Hierochloe odorata	AM	599, 260, 261
Holcus lanatus	AM	395, 586
	AM + NM	260, 261
Holcus mollis	AM	194, 260, 261
Homolepsis aturensis	AM	142
Hordeum brachyantherum	AM	293
Hordeum comosum	AM	207
Hordeum distichon	AM	260, 261
Hordeum jubatum	AM	302, 626
Hordeum murinum	AM	260, 261
Hordeum vulgare	AM	119
	AM + NM	260, 261
Imperata cylindrica	AM	422
Ischaemum byronis	AM	326
Koeleria glauca	NM	260, 261
Koeleria macrantha	AM	260, 261
Koeleria pyramidata	NM	274
Koeleria vurilochensis	NM	207
Lagurus ovatus	AM	260, 261
Lasiurus sindicus	AM	567
Leersia hexandra	AM	404
Leersia oryzoides	AM	58, 140
	NM	260, 261
Leymus arenarius	AM	240, 241
	NM	260, 261
Lolium perenne	AM	23, 140, 171, 307
Lolium perenne ssp. multiflorum	AM	260, 261
Lolium perenne ssp. perenne	AM	260, 261
Lolium temulentum	AM + NM	260, 261
Lygeum spartum	AM	170
Melica nutans	AM + NM	260, 261
Melica uniflora	NM	260, 261
Microstegium ciliatum	AM	422
Milium effusum	AM + NM	260, 261
Molinia caerulea	AM	586, 260, 261
Mulenbergia porteri	AM	137
Nardus stricta	AM	194, 269, 260, 261
Nassella leucotricha	AM	604
Neyraudia reynaudiana	AM	343
Oryza sativa	AM	536
Oryzopsis hymenoides	AM	11
Palicourea rigida	AM	358
Panicum amarum	AM	43

Examined species[a]	Mycorrhizal status[b,c]	References
Panicum clandestinum	AM	58
Panicum hemitomon	AM	404
Panicum laxum	AM	149
Panicum maximum	AM	20
Panicum micranthum	AM	358
Panicum nephelophilum	AM	326
Panicum purpurascens	AM	143
Panicum virgatum	AM	83, 134
	Weak AM	626
Panicum virginatum	AM	193
Paractaenum novae-hollandiae	NM	438
Parapholis incurva	AM	260, 261
Paspalidium flavidum	AM	343
Paspalum cf. carinatum	AM	358
Paspalum conjugatum	AM	142
Paspalum dilatatum	AM	243
Paspalum notatum	AM	193, 295, 562
Paspalum thunbergii	AM	643
Pennisetum alopecuroides	AM	643
Pennisetum glaucum	AM	51, 567
Pennisetum padicillatum	AM	544
Pennisetum parviflorum	AM	545
Pennisetum setaceum	AM	326
Phalaris arundinacea	AM	58, 140
	NM	62
	AM + NM	260, 261
Phleum alpinum	AM	194, 260, 261
Phleum arenarium	NM	260, 261
Phleum phleoides	AM + NM	260, 261
Phleum pratense	AM	132, 194, 260, 261
Phragmites australis	NM	62
	AM	140, 368
	AM + NM	260, 261
Phragmites communis	AM	620
Piptatherum miliaceum	AM	497
Poa alpina	AM + NM	260, 261
Poa angustifolia	AM	307
Poa annua	AM	560, 643
	NM	342
	AM + NM	260, 261
Poa arctica	NM	594
Poa compressa	NM	307
	AM + NM	260, 261
Poa cookie	NM	560
	AM	342
Poa flexuosa	AM + NM	260, 261
Poa foliosa	NM	342
Poa kerguelensis	AM	560
Poa lanuginosa	AM	207
Poa literosa	NM	342
Poa nemoralis	AM + NM	260, 261
Poa palustris	AM + NM	260, 261
Poa pratensis	AM	194, 467, 626
	AM + NM	260, 261
Poa trivialis	AM + NM	260, 261
Polypogon monspeliensis	AM	260, 261
Puccinellia distans	AM + NM	260, 261
Puccinellia macquariensis	AM	342
Puccinellia maritima	AM + NM	260, 261
Puccinellia nuttalliana	AM	301
Raddiella esembeckii	AM	358
Rhynchelytrum repens	AM	355
Saccharum officinarum	AM	326, 489
Saccharum spontaneum	Weak AM	439
Schizachyrium scoparium	Facultative AM	29
	AM	117, 140
Schizachyrium stoloniferum	AM	415
Secale cereale	AM	512
	AM + NM	260, 261
Sesleria albicans	AM + NM	260, 261
Setaria glauca	AM	643
Setaria pumila	AM	260, 261
Setaria verticillata	AM	260, 261
Setaria viridis	AM	643
	AM + NM	260, 261
Sorghastrum nutans	AM	264
Sorghum bicolor	AM	171
Sorghum halpense	AM	193
Sorghum sudanense	AM	311
Spartina alterniflora	NM	278
	Weak AM	391
Spartina anglica	NM	260, 261
Spartina cynosuroides	AM	278, 391
Spartina gracilis	AM	302
Spartina patens	AM	97, 278, 324
Spartina pectinata	AM	626
Spartina × townsendii	NM	260, 261
Sphenopholis obtusa	AM	625
Sporobolus heterolepis	AM	168
Sporobolus virginicus	AM	144, 326
Sporobolus wrightii	AM	491
Stipa tenacissima	AM	497
Themeda triandra	AM	23
Thysanolaena maxima	AM	422
Trachypogon gouinii	AM	144
Trachypogon plumosus	AM	149, 353, 358
Triodia basedowii	Weak AM	438
Tripogon filiformis	AM	343
Triraphis mollis	Weak AM	438
Trisetum flavescens	AM	207, 260, 261
Triticum aestivum	AM	15
Triticum durum	AM	10
Uniola paniculata	AM	563

Examined species[a]	Mycorrhizal status[b,c]	References
Vulpia ciliata ssp. ambigua	AM	110
Zea mays	AM	123
Zoysia japonica	AM	326
Commelinaceae		
Amischotolype hispida	AM	655
Commelina communis	AM	294
	NM	643
Commelina aff. erecta	AM	143
Musaceae		
Musa acuminata	AM	163
Heliconiaceae		
Heliconia psittacorum	AM	510
Cannaceae		
Canna coccinea	NM	510
Zingiberaceae		
Alpinia conchigera	AM	655
Amomum villosum	AM	422
Costus speciosus	AM	422
Paramomum petaloideum	AM	655
Renealmia guianensis	AM	510
Costaceae		
Costus scaber	AM	510
Costus spiralis var. spiralis	AM	510
Myristicaceae		
Horsfieldia pandurifolia	AM	655
Horsfieldia tetratepala	AM	422
Myristica yunnanensis	AM	655
Pycnanthus angolensis	AM	445
Staudtia kamerunensis	AM	445
Magnoliaceae		
Liriodendron tulipifera	AM	362, 470
Magnolia henryi	AM	422, 655
Talauma ovata	NM	548
Annonaceae		
Annona cherimola	AM	42
Enantia chlorantha	AM	445
Goniothalamus griffithii	AM	422, 655
Hexalobus crispiflorus	AM	445
Mitrephora calcarea	AM	655
Pseuduvaria indochinensis	NM	655
Lauraceae		
Beilschmiedia pendula	AM	356, 357
Cryptocarya angulata	AM	222
Cryptocarya mackinnoniana	AM	222
Cryptocarya yunnanensis	AM	422
Laurus nobilis	AM	368, 603
Lindera benzoin	AM	140
Litsea dileniifolia	AM	655
Litsea liyuyingi	AM	655
Nectandra rigida	AM	31
Ocotea indecora	AM	651
Ocotea puberula	AM	651
Persea americana	AM	41, 250, 326, 609
Phoebe lanceolata	AM	422
Aristolochiaceae		
Asarum europaeum	AM + NM	260, 261
Piperaceae		
Peperomia hesperomannii	AM	326
Peperomia membranacea	AM	326
Piper longum	AM	422, 655
Piper nigrum	AM	578
Piper sarmentosum	AM	422
Piper sp.	NM	422
Papaveraceae		
Chelidonium majus	NM	260, 261
Macleaya cordata	AM	343
Papaver rhoeas	AM + NM	260, 261
Papaver somniferum	NM	260, 261
Menispermaceae		
Cocculus trilobus	AM	326
Berberidaceae		
Berberis buxifolia	AM	207
Berberis darwinii	NM	207
Berberis vulgaris	AM	260, 261
Mahonia aquifolium	AM	260, 261
Podophyllum peltatum	AM	410, 621
Ranunculaceae		
Aconitum delphinifolium	AM	594
Aconitum napellus	AM + NM	260, 261
Actea spicata	AM + NM	260, 261
Anemone nemorosa	AM + NM	260, 261
Anemone ranunculoides	AM	260, 261
Anemone vulgaris	AM	260, 261
Batrachium circinatum	NM	62
Batrachium peltatum	NM	62
Caltha palustris	NM	62
	AM + NM	260, 261
Clematis stans	AM	636
Clematis vitalba	AM	368
	AM + ECM	260, 261
Consolida ambigua	AM	260, 261
Corydalis lutea	NM	260, 261
Corydalis solida	NM	260, 261
Fumaria officinalis	AM + NM	260, 261
Helleborus foetidus	AM	260, 261
Myosurus minimus	AM	260, 261
Pulsatilla patens	AM	408
Pulsatilla pratensis	AM	408
Pulsatilla vulgaris	AM + NM	260, 261
Ranunculus acris	AM	194, 456, 586, 260, 261
Ranunculus acris ssp. pumilus	AM	503
Ranunculus adoneus	AM	416, 519

Examined species[a]	Mycorrhizal status[b,c]	References
Ranunculus auricomus	AM	586
	AM + NM	260, 261
Ranunculus biternatus	AM	560
Ranunculus bulbosus	AM	456, 260, 261
Ranunculus crassipes	AM	342
Ranunculus ficaria	AM + NM	260, 261
Ranunculus flammula	AM	62
	AM + NM	260, 261
Ranunculus fluitans	NM	260, 261
Ranunculus lingua	AM + NM	260, 261
Ranunculus nemorosus	AM	586
Ranunculus paludosus	AM	260, 261
Ranunculus repens	AM + NM	260, 261
Ranunculus reptans× flammula	AM	260, 261
Ranunculus sardous	AM	260, 261
Ranunculus sceleratus	AM + NM	260, 261
Thalictrum minus	AM	260, 261
Trollius europaeus	AM	194, 503, 260, 261
Proteaceae		
Banksia aricifolia	Weak AM	454
Conospermum longifolium	AM	67
Conospermum taxifolium	AM	67
Lomatia hirsute	NM	207
Grevillea robusta	NM	326
Telopea speciosissima	AM	67
Buxaceae		
Buxus sempervirens	AM	260, 261
Gunneraceae		
Gunnera petaloidea	AM	326
Dilleniaceae		
Hibbertia serpyllifolia	AM	67
Droseraceae		
Drosera anglica	NM	326, 260, 261
Drosera intermedia	AM	212
	NM	260, 261
Drosera rotundifolia	AM	140
	AM + NM	260, 261
Frankeniaceae		
Frankenia laevis	NM	260, 261
Frankenia plicata	Weak AM	438
Tamaricaceae		
Tamarix chinensis	AM	620
Tamarix gallica	AM	368
Plumbaginaceae		
Armeria maritime	AM	277
	AM + NM	260, 261
Armeria maritima ssp. halleri	AM	456
Limonium vulgare	AM + NM	260, 261
Polygonaceae		
Bistorta vivipara	AM	194

Examined species[a]	Mycorrhizal status[b,c]	References
Coccoloba uvifera	ECM	326
Coccoloba warmingii	AM	31
Fagopyrum esculentum	NM	260, 261
Fallopia convolvulus	NM	260, 261
Oxyria digyna	NM	260, 261
Polygonum amphibium	Facultative AM	62, 626
	NM	260, 261
Polygonum aviculare	NM	307
	AM + NM	260, 261
Polygonum bistorta	NM	594
	AM	260, 261
Polygonum capitatum	ECM + weak AM	326
Polygonum cespitosum	AM	140
Polygonum cuspidatum	AM	636
	NM	643
Polygonum hydropiper	NM	260, 261
Polygonum lapathifolium	NM	260, 261
Polygonum lapathifolium ssp. pallidum	NM	307
Polygonum longisetum	NM	643
Polygonum maritimum	NM	260, 261
Polygonum mite	NM	260, 261
Polygonum pesicaria	Weak AM	626
	AM + NM	260, 261
Polygonum statice	AM	343
Polygonum viviparum	ECM	594
	AM + ECM	260, 261
Polygonum weyrichii	ECM	587
Polygonum weyrichii var. alpinum	NM	636
Rumex acetosa	AM	194, 294, 456
	AM + NM	260, 261
Rumex acetosella	NM	207, 456
Rumex acetosella agg.	NM	260, 261
Rumex alpinus	AM + NM	260, 261
Rumex altissimus	AM	140
Rumex conglomeratus	NM	260, 261
Rumex crispus	NM	307
	AM + NM	260, 261
Rumex hastatus	AM	343
Rumex hydrolapathum	NM	62
Rumex japonicus	NM	643
Rumex longifolius	Weak AM	194
Rumex obtusifolius	AM + NM	260, 261
Rumex palustris	NM	260, 261
Rumex scutatus	NM	260, 261
Ruprechtia laxiflora	NM	651
Caryophyllaceae		
Agrostemma githago	NM	260, 261
Arenaria serpyllifolia	NM	260, 261
Cerastium alpinum	NM	260, 261
Cerastium arcticum	NM	260, 261

Examined species[a]	Mycorrhizal status[b,c]	References
Cerastium arvense	AM	456
	NM	260, 261
Cerastium cerastoides	NM	260, 261
Cerastium fontanum	AM	194
	NM	456
Cerastium fontanum ssp. fontanum	AM	342
Cerastium fontanum ssp. glabrescens	AM + NM	260, 261
Cerastium glomeratum	NM	560
Cerastium holosteoides var. hallaisanense	NM	643
Cerastium semidecandrum	NM	260, 261
Colobanthus apetalus var. alpinus	AM	342
Colobanthus kerguelensis	NM	560
Colobanthus muscoides	NM	342
Dianthus carthusianorum	AM	456
	NM	260, 261
Dianthus caryophyllus	NM	554
Dianthus deltoides	NM	260, 261
Dianthus gratianopolitanus	NM	260, 261
Gypsophila fastigiata	NM	456
Honkenya peploides	NM	260, 261
Lychnis flos-cuculi	AM + NM	260, 261
Lychnis viscaria	NM	260, 261
Minuartia hybrida	AM	260, 261
Minuartia verna	NM	260, 261
Moehringia trinervia	NM	260, 261
Myosoton aquaticum	NM	260, 261
Polycarpaea corymbosa	AM	336
Sagina apetala	NM	260, 261
Sagina procumbens	NM	260, 261
Sagina subulata	NM	260, 261
Saponaria officinalis	NM	260, 261
Scleranthus annuus	NM	260, 261
Silene acaulis	AM	594
	AM + ECM + NM	260, 261
Silene alba	NM	260, 261
Silene colorata ssp. canescens	AM	368
Silene dioica	Weak AM	194
	NM	260, 261
Silene maritima	NM	260, 261
Silene nutans	NM	260, 261
Silene otites	AM	260, 261
Silene vulgaris	NM	456, 260, 261
Schiedea spergulina	AM	326
Spergula arvensis	AM + NM	260, 261
Spergularia marina	AM or NM	260, 261
Spergularia media	AM + NM	260, 261
Stellaria alsine	NM	260, 261
Stellaria graminea	NM	260, 261
Stellaria holostea	AM + NM	260, 261
Stellaria media	AM	294
	AM + NM	260, 261
Stellaria media ssp. media	AM	342
Stellaria nemorum	AM + NM	260, 261
Stellaria pallida	AM + NM	260, 261
Stellaria palustris	NM	260, 261
Stellaria parviflora	NM	342
Amaranthaceae		
Achyranthes aspera	NM	422
	AM	343
Achyranthes fauriei	NM	643
Achyranthes splendens	NM	326
Amaranthus caudatus	AM	33
Amaranthus lividus	AM	294
Amaranthus retroflexus	NM	260, 261
Amaranthus spinosus	NM	422
	AM	343
Amaranthus tricolor	AM	33
Amaranthus viridis	AM	343
Atriplex barclayana	Weak AM	112
Atriplex canescens	AM	57
Atriplex glabriuscula	NM	260, 261
Atriplex halimus	NM	368
Atriplex hortensis	NM	260, 261
Atriplex julacea	AM	543
Atriplex limbata	NM	438
Atriplex littoralis	AM	260, 261
Atriplex patula	AM	260, 261
Atriplex prostrata	NM	260, 261
Atriplex semibaccata	NM	326
Beta vulgaris	AM	260, 261
Celosia cristata	AM	33
Chenopodium album	NM	307
	AM + NM	260, 261
Chenopodium ambrosioides	AM	343
Chenopodium bonus-henricus	NM	260, 261
Chenopodium glaucum	NM	260, 261
Chenopodium murale	NM	326
Chenopodium rubrum	NM	260, 261
Enchylaena tomentosa	NM	438
Gomphrena globosa	AM	33
Halimione portulacoides	AM + NM	260, 261
Nototrichium sandwicense	NM	326
Ptilotus latifolius	NM	438
Ptilotus obovatus var. obovatus	NM	438
Ptilotus sessilifolius	NM	438
Salicornia europaea	AM	277
	AM + NM	260, 261

Examined species[a]	Mycorrhizal status[b,c]	References
Salsola kali	NM	19, 300, 260, 261
	AM + NM	438
Sclerolaena diacantha	AM	438
Sclerolaena holtiana	NM	438
Suaeda glauca	AM	620
Suaeda maritima	AM	533
	AM + NM	260, 261
Suaeda vera	AM + NM	260, 261
Aizoaceae		
Cheredospsis purpurea	NM	417
Delosperma herbium	Falcutative AM	417
Sesuvium portulacastrum	NM	326
	AM	143
Tetragonia tetragonioides	AM	326
Phytolaccaceae		
Stegnosperma halimifolia	AM	112
Nyctaginaceae		
Abronia maritima	Falcutative AM	543
Abronia umbellata	AM	543
Boerhavia repens	NM	326
Bougainvillea spectabilis	NM	326, 651
Mirabilis jalapa	NM	326
Neea sp.	ECM	656
Pisonia sp.	ECM	656
Pisonia umbellifera	NM	326
Cactaceae		
Chamacereus sylvestris	NM	417
Cochemia poselgeri	AM	112
Coryphanta radians	Weak AM	103
Escontria chiotilla	Weak AM	103
Ferocactus acanthodes	AM	151
Ferocactus flavovirens	Weak AM	103
Ferocactus latispinus	Weak AM	103
Ferocactus peninsulae	AM	112
Lemaireocereus thurberi	Weak AM	112
Lophocereus schottii	AM	112
Machaerocereus gummosus	Weak AM	112
Mammilaria carnea	Weak AM	103
Mammilaria dioica	Weak AM	112
Mamillaria elongata	NM	417
Myrtillocactus geometrizans	Weak AM	103
Neobuxbaumia tetetzo	Weak AM	103
Nopalea karwinskiana	AM	20
Opuntia cholla	AM	112
Opuntia excelsa	AM	20
Opuntia ficus-indica	AM	151
Opuntia lindsayi	AM	112
Opuntia pilifera	AM	103
Opuntia puberula	AM	20
Opuntia streptacantha	AM	103
Opuntia stricta var. dillenii	AM	143
Opuntia tuna	NM	417
Pachycereus pectin-aboriginum	AM	494
Pachycereus pringlei	Weak AM	112
Selenicereus macdonaldiae	AM	417
Stenocereus queretaroensis	AM	463, 464
Stenocereus stellatus	Weak AM	103
Portulacaceae		
Lyallia kerguelensis	NM	560
Montia fontana ssp. fontana	NM	342
Montia perfoliata	NM	207
Montia sibirica	AM	260, 261
Portulaca intraterranea	NM	438
Portulaca lutea	NM	326
Portulaca oleracea	AM + NM	260, 261
Portulaca sclerocarpa	NM	326
Olacaceae		
Coula edulis	AM	445
Ongokea gore	AM	445
Strombosis grandifolia	AM	445
Loranthaceae		
Viscum album	NM	260, 261
Santalaceae		
Santalum ellipticum	NM	326
Santalum paniculatum	AM	326
Thesium alpinum	NM	456
Thesium humifusum	NM	260, 261
Loasaceae		
Caiophora sylvestris	NM	207
Loasa berghii	NM	207
Cornaceae		
Cornus sanguinea	AM + NM	260, 261
Balsaminaceae		
Impatiens capensis	AM	140
Impatiens glandulifera	AM + NM	260, 261
Impatiens noli-tangere	AM + NM	260, 261
Impatiens parviflora	AM + NM	260, 261
Impatiens walleriana	AM	322
Tetrameristaceae		
Tetramerista glabra	AM	568
Polemoniaceae		
Polemonium caeruleum	AM	260, 261
Fouquieriaceae		
Fouquieria digueti	AM	112
Theaceae		
Pyrenaria cheliensis	AM	422
Ebenaceae		
Diospyros nigrocartex	AM	422, 655
Theophrastaceae		
Jacquinia pungens	AM	20
Primulaceae		
Anagallis arvensis	AM	472, 260, 261

Examined species[a]	Mycorrhizal status[b,c]	References
Anagallis tenella	AM	260, 261
Asterolinum stellatum	AM	472
Cyclamen hederifolium	AM	260, 261
Glaux maritima	AM	260, 261
Hottonia palustris	AM + NM	260, 261
Lysimachia japonica	AM	643
Lysimachia nemorum	AM + NM	260, 261
Lysimachia nummularia	AM + NM	260, 261
Lysimachia terrestris	AM	140
	AM + NM	260, 261
Lysimachia thyrsiflora	NM	62
	AM + NM	260, 261
Lysimachia vulgaris	AM	368
	AM + NM	260, 261
Primula elatior	AM	260, 261
Primula farinosa	AM	260, 261
Primula veris	AM + NM	260, 261
Primula vulgaris	AM	260, 261
Samolus valerandi	AM	368, 260, 261
Trientalis europaea	AM	501
	AM + NM	260, 261
Myrsinaceae		
Ardisia crenata	AM	87
Ardisia tenera	AM	422, 655
Measa indica	AM	422
Myrsine alyxifolia	AM	326
Rapanea ferruginea	AM	31
Styracaceae		
Strichinus brasiliensis	AM	651
Diapensiaceae		
Diapensia lapponica	ERM	260, 261
Lecythidaceae		
Barringtonia macrostachya	AM	655
Barringtonia racemosa	AM	655
Cariniana estrellensis	AM	651
Sapotaceae		
Aningeria adolfi-friedericii	AM	637, 638
Aningeria robusta	AM	445
Argania spinosa	AM	434
Autranella congolensis	AM	445
Baillonella toxisperma	AM	445
Gambeya africana	AM	445
Omphalocarpum procerum	AM	445
Palaquium gutta	AM	568
Actinidiaceae		
Actinidia deliciosa	AM	523
Clethraceae		
Clethra barbinervis	AM	335
Ericaceae		
Andromeda polifolia	ERM	260, 261
Arbutus menziesii	ABM	374
	ECM	375

Examined species[a]	Mycorrhizal status[b,c]	References
Arbutus unedo	ABM	200, 238, 421, 368, 472, 260, 261
Arctostaphylos alpinus	ABM	594
	ERM	260, 261
Arctostaphylos uva-ursi	ABM	259, 507
	M(endo) + ERM + ABM + ECM + EEM	260, 261
Calluna vulgaris	ERM	72, 238, 299, 260, 261
Cassiope tetragona	ERM	594
Cavendishia capitulata	ERM	474
Cavendishia melastomoides	ERM	474
Daboecia cantabrica	ERM	260, 261
Disterigma humboldtii	ERM	474
Empetrum nigrum	ERM	594, 260, 261
Erica arborea	ERM	368
Erica cinerea	ERM	99, 260, 261
Erica erigena	ERM	260, 261
Erica mackaiana	ERM	260, 261
Erica multiflora	ERM	472
Erica tetralix	ERM	260, 261
Erica vagans	ERM	260, 261
Gaultheria erecta	ERM	474
Gaultheria procumbens	ERM	238
Gaultheria shallon	ERM	22, 639
Gonocalyx costaricense	ERM	474
Kalmia latifolia	ERM	238
Ledum palustre	ERM	260, 261
Ledum palustre ssp. decumbens	ERM	594
Ledum palustre ssp. groenlandicum	ERM	594
Leucopogon parviflorus	ERM	401
Leucothoe fontanesiana	ERM	238
Loiseleuria procumbens	ERM	594, 260, 261
Oxydendrum arboreum	ERM	238
Pernettya mucronata	ERM	207
Phyllodoce caerulea	ERM	260, 261
Pieris floribunda	ERM	238, 555
Rhododendron brachycarpum	ERM	154
Rhododendron calendulaceum	ERM	238
Rhododendron carolinianum	ERM	238
Rhododendron catawbiense	ERM	238
Rhododendron maximum	ERM	238
Rhododendron mucronulatum	ERM	238
Rhododendron obtusum	ERM	601

Examined species[a]	Mycorrhizal status[b,c]	References
Rhododendron ponticum	ERM	260, 261
Sphyospermum buxifolium	ERM	474
Sphyospermum cordifolium	ERM	474
Vaccinium angustifolium	ERM	157
Vaccinium calycinum	ERM + AM	325, 326
Vaccinium corymbosum	ERM	238, 645
Vaccinium dentatum	ERM + AM	325, 326
Vaccinium macrocarpon	ERM	99, 238, 260, 261
Vaccinium myrtillus	ERM	72, 260, 261
Vaccinium oxycoccos	ERM	260, 261
Vaccinium reticulatum	ERM + weak AM	326
	ERM + AM	325
Vaccinium uliginosum	ERM	594, 260, 261
Vaccinium vitis-idaea	ERM	594, 260, 261
Woollsia pungens	ERM	401
Ericaceae "Pyrolaceae"		
Moneses uniflora	EEM + M(endo)	260, 261
Orthilia secunda	EEM + M(endo)	260, 261
Pyrola media	M(endo)	260, 261
Pyrola minor	EEM + M(endo)	260, 261
Pyrola rotundifolia	EEM + M(endo)	260, 261
Ericaceae (Monotropoideae)		
Monotropa hypopitys	MTM	260, 261
Monotropa uniflora	MTM	647
Monotropastrum humile	MTM	384
Sarcodes sanguinea	ERM + MTM	332
Ericaceae (Epacridoideae)		
Astroloma conostephioides	ERM	393
Astroloma humifusum	ERM	393
Astroloma pinifolium	ERM	393, 394
Brachyloma daphnoides	AM	67
	ERM	393
Epacris impressa	ERM	393, 394
Epacris impressa var. grandiflora	ERM	393
Epacris microphylla	AM	67
	ERM	128
Leucopogon ericoides	ERM	393
Leucopogon juniperinus	AM	67
Leucopogon parviflorus	ERM	393, 556
Lysinema ciliatum	ERM	36
Styphelia adscendens	ERM	393
Styphelia tameiameiae	ERM + AM	325, 326
Woollsia pungens	ERM	127, 312
Icacinaceae		
Pittosporopsis kerrii	AM	422
Boraginaceae		
Arnebia hispidisima	AM	567
Borago officinalis	NM	260, 261
Bourreria sonorae	AM	112
Cerastium arvense	NM	207
Cordia alliodora	AM	20
Cordia curassavica	Weak AM	103
Cordia ecalyculata	AM	651
Cordia trichotoma	AM	651
Cynoglossum creticum	AM	207
Cynoglossum lanceolatum	AM	343
Echium vulgare	AM	260, 261
Heliotropium anomalum	AM	326
Heliotropium curassavicum	AM	326
Heliotropium sp.	AM	567
Lithospermum arvense	NM	260, 261
Lithospermum officinale	NM	260, 261
Lithospermum purpurocaeruleum	AM	260, 261
Myosotis alpestris	AM + NM	260, 261
Myosotis arvensis	NM	260, 261
Myosotis decumbens	Facultative AM	194
Myosotis discolor	AM	260, 261
Myosotis laxa ssp. caespitosa	AM	260, 261
Myosotis palustris	Facultative AM	62
Myosotis ramosissima	AM + NM	260, 261
Myosotis scorpioides	AM + NM	260, 261
Myosotis sylvatica	AM + NM	260, 261
Omphalalappula concava	NM	438
Plagiobothrys figuratus	AM	293
Pulmonaria officinalis	AM + NM	260, 261
Silene andicola	NM	207
Stellaria graminea	AM	194
Stellaria media	AM	207
Symphytum officinale	AM	260, 261
Symphytum tuberosum	AM + NM	260, 261
Tournefortia argentea	AM	326
Trichodesma zeylanicum	AM	438
Rubiaceae		
Asperula cynanchica	AM	260, 261
Borreria articularis	AM	336
Borreria pusilla	AM	336
Canthium parvifoliam	AM	422
Cephalanthus occidentalis	AM	140
Chesalia curviflora	AM	422, 655
Coffea arabica cv. guatemala	AM	602
Coprosma ernodeoides	AM	326
Coprosma kauensis	AM	326
Coprosma perpusilla ssp. subantarctica	NM	342
Declieuxia fruticosa	AM	149
Duperrea pavettaefolia	AM	655
Galium album	AM	194, 260, 261
Galium antarcticum	AM	560
Galium aparine	NM	207
	AM + NM	260, 261
Galium boreale	AM	260, 261

Examined species[a]	Mycorrhizal status[b,c]	References
Galium cruciata	AM	260, 261
Galium mollugo	AM	456
	AM + NM	260, 261
Galium odoratum	AM + NM	260, 261
Galium palustre	AM + NM	260, 261
Galium saxatile	AM + NM	260, 261
Galium sp.	AM	140
Galium uliginosum	NM	260, 261
Galium verum	AM	260, 261
Geophila herbacea	AM	422, 655
Hedyotis costata	AM	422
Hedyotis elatior	AM	326
Hedyotis foggiana	AM	326
Hedyotis terminalis	AM	326
Lasianthus hookeri	AM	422
Lasianthus sikkimensis	AM	655
Lasianthus verticillatus	AM	655
Metadina trichotoma	AM	655
Mitragina ciliata	AM	445
Morinda lucida	AM	422
Mycetia hirta	AM	655
Nauclea diederrichii	AM	445
Neonauclea tsaiana	AM	655
Nertera granadensis	AM	326
Oldenlandia aspera	AM	336
Ophiorrhiza austro-yunnanensis	AM	422
Paederia scandens	AM	643
Pausynistalia johimbe	AM	445
Prismatomeria tetrandra	AM	422
Psychotria calocarpa	AM	655
Psychotria henryi	AM	422
Psychotria siamica	NM	655
Psychotria sp.	AM	326
Randia ruglosa	AM	315
Relbuneum hypocarpium	AM	207
Relbuneum richardianum	AM	207
Rubia peregrina	AM	368
	AM + ECM	472
	ECM	260, 261
Sherardia arvensis	AM	472
Vangueria infausta	AM	84, 85
Vangueria infausta ssp. infausta	AM	221
Gentianaceae		
Blackstonia perfoliata	AM	368, 472
	AM + NM	260, 261
Centaurium erythraea	AM	472, 260, 261
Gentiana algida	NM	594
Gentiana nivalis	AM + NM	260, 261
Gentiana pneumonanthe	AM + NM	260, 261

Examined species[a]	Mycorrhizal status[b,c]	References
Gentiana verna	AM	561, 260, 261
Gentianella amarella	AM	260, 261
Gentianella campestris	AM	194, 260, 261
Gentianella germanica	AM	456, 260, 261
Voyria aurantiaca	Mycoheterotrophy (via AM)	79
Voyria caerulea	Mycoheterotrophy (via AM)	79
Voyria corymbosa	Mycoheterotrophy (via AM)	79
Voyria obconica	Mycoheterotrophy (via AM)	292
Voyria rosea	Mycoheterotrophy (via AM)	79
Voyria tenuiflora	Mycoheterotrophy (via AM)	79
Voyriella parviflora	Mycoheterotrophy (via AM)	79
Loganiaceae		
Anthocleista schweinfurthii	AM	445
Buddleia asiatica	AM	326
Apocynaceae		
Adenium obesum	AM	623
Adenium somalense	AM	623
Allamanda cathartica var. schotti	AM	623
Allamanda violacea	AM	623
Alstonia boonei	AM	445
Alyxia oliviaeformis	AM	326
Amsonia tabernaemontana	AM	623
Apocynum cannabinum	AM	623
Apocynum medium	AM	623
Aspidosperma parvifolium	NM	548
Aspidosperma polyneuron	NM	651
Catharanthus roseus	AM	623
Dyera costulata	NM	568
Landolphia heudelottii	NM	47
Mandevilla sanderei	AM	623
Nerium oleander	AM	623
Pachypodium lamerei	AM	623
Picralima nitida	AM	445
Plumeria obtuse	AM	623
Plumeria rubra	AM	623
Rauwolfia serpentina	AM	623
Rauwolfia verticillata	AM	623
Saba senegalensis	NM	47
Stemmadenia donnell-smithii	AM	244
Strophanthus capensis	AM	623
Tabernaemontana australis	AM	651
Thevetia peruviana	AM	623

Examined species[a]	Mycorrhizal status[b,c]	References
Trachelospermum jasminoides	AM	623
Vinca major	AM	260, 261
Vinca minor	AM	623, 260, 261
Apocynaceae (Asclepiadoideae)		
Asclepias incarnata	AM	58, 140
Calotropis gigantea	AM	343
Cynanchum nummularifolium	AM	207
Periploca graeca	NM	368
Stapelia glabricaulis	AM	417
Oleaceae		
Fraxinus excelsior	AM	465, 622
	AM + ECM	260, 261
Fraxinus ornus	AM	368
Fraxinus oxycarpa	AM	368
Fraxinus pennsylvanica	AM	28
Jasminum laurifolium	AM	655
Jasminum wangii	AM	422
Ligustrum vulgare	AM	368, 260, 261
Olea europaea	AM	17, 101
Olea europaea ssp. cuspidate	AM	637, 638
Olea europaea ssp. sylvestris	AM	108, 368
Olea europaea var. oleaster	AM	472
Phillyrea angustifolia	AM	368, 472
Phillyrea latifolia	AM	368
Gesneriaceae		
Corallodiscus flabellatus	AM	343
Cytrandra longifolia	AM	326
Pedaliaceae		
Sesamum indicum	AM	612
Plantaginaceae		
Callitriche hamulata	AM	260, 261
Littorella uniflora	AM	62, 432, 260, 261
Plantago coronopus	AM	260, 261
Plantago drummondii	AM	438
Plantago lanceolata	AM	194, 307, 446, 456, 260, 261
Plantago major	AM	49, 368, 260, 261
Plantago major ssp. intermedia	AM	260, 261
Plantago maritima	AM	260, 261
Plantago media	AM	48, 194, 260, 261
Plantago princeps	AM	326
Bignoniaceae		
Incarvillea arguta	AM	343
Jacaranda mimosaefolia	AM	548, 651
Jacaranda puberula	AM	651
Oroxylum indicum	AM	655
Stenolobium stans	AM	548
Tabebuia chrysotricha	AM	651
Tabebuia roseo-alba	AM	651
Tecoma stans	Weak AM	103
	AM	112
Zeyheria tuberculosa	NM	651
Verbenaceae		
Aegiphila sellowiana	AM	651
Citharexylum myrianthum	AM	651
Clerodendron japonicum	AM	422
Lantana camara	AM	326
Lippia graveolens	Weak AM	103
Lippia nodiflora	AM	143
Tectona grandis	AM	476
Teucrium flavum	AM	368
Verbena hastata	AM	140
Verbena officinalis	AM	260, 261
Vitex agnus-castus	AM	368
Vitex montevidensis	AM	651
Vitex negundo	AM	343
Vitex rotundifolia	AM	326
Vitex vestita	AM	655
Lamiaceae		
Ajuga genevensis	AM	260, 261
Ajuga pyramidalis	AM	194
Ajuga reptans	AM	260, 261
Ballota nigra	NM	260, 261
Betonica officinalis	AM	212
Clinopodium gracile	AM	643
Clinopodium vulgare	AM + NM	260, 261
Colebrookea oppositifolia	AM	655
Coleus parviflorus	AM	469
Coleus × hybridus	AM	322
Collinsonia canadensis	AM	140
Elsholtzia blanda	AM	422
Elsholtzia cypriani	AM	343
Galeopsis segetum	NM	260, 261
Galeopsis tetrahit	NM	260, 261
Glechoma hederacea	AM + NM	260, 261
Gomphostemma microdon	AM	655
Hyptis lantiflora	AM	112
Lamiastrum galeobdolon	AM + NM	260, 261
Lamium album	AM	260, 261
Lamium amplexicaule	AM	294, 260, 261
Lamium purpureum	AM	260, 261
Lavandula augustifolia	AM	348
Lavandula officinalis	AM	104
Lavandula pedunculata	AM	339
Lavandula spica	AM	39
Leucas aspera	AM	336
Lycopus europaeus	AM + NM	260, 261

Examined species[a]	Mycorrhizal status[b,c]	References
Melittis melissophyllum	AM + NM	260, 261
Mentha aquatica	AM	368
	AM + NM	260, 261
Mentha arvensis	AM	248
	AM + NM	260, 261
Mentha arvensis ssp. haplocalyx	AM	1
Mentha cardiaca	AM	1
Mentha citrata	AM	1
Mentha piperita	AM	1
	AM + NM	260, 261
Mentha pulegium	AM	260, 261
Mentha spicata	AM	1
Mentha viridis	AM	1
Nepeta cataria	AM	260, 261
Ocimum basilicum	AM	105, 171, 343
Origanum vulgare	AM	260, 261
Paraphlomis javanica	AM	655
Prunella vulgaris	AM	194, 586
	AM + NM	260, 261
Pycnanthemum tenuifolium	AM	140, 599
Pycnanthemum virginianum	AM	140
Rosmarinus officinalis	AM	472
Salvia azurea	AM	633
Salvia officinalis	AM	105
Salvia pratensis	AM	260, 261
Salvia splendens	AM	322
Salvia verbenaca	AM	260, 261
Scutellaria galericulata	AM + NM	260, 261
Stachys × ambigua	AM	260, 261
Stachys maritima	AM	368
Stachys officinalis	AM	260, 261
Stachys palustris	AM	260, 261
Stachys recta var. psammophila	NM	368
Stachys sylvatica	AM + NM	260, 261
Stenogyne purpurea	AM	326
Teucrium chamaedrys	AM	260, 261
Teucrium fruticans	AM	348, 472
Teucrium scordium	AM	260, 261
Teucrium scordonia	AM	260, 261
Thymus mastichina	AM	339
Thymus polytrichus ssp. britannicus	AM	630
Thymus pulegioides	AM	456
Thymus serpyllum	AM	456, 260, 261
Thymus vulgaris	AM	105, 583
Thymus zygis	AM	339
Acanthaceae		
Barleria cristata	AM	343
Carlowrightia californica	AM	112
Justicia procumbens var. leucantha	AM	643
Phlogacanthus curviflorus	AM	655
Pseudoranthemum palatiferum	AM	422, 655
Ruellia peninsularis	AM	112
Scrophulariaceae		
Antirrhinum majus	AM	74
Bartsia alpina	AM + NM	260, 261
Buddleja davidii	NM	260, 261
Calceolaria crenatiflora	AM	207
Calceolaria polyrrhiza	AM	207
Castilleja arvensis	NM	326
Chaenorhinum minus	NM	260, 261
Cymbalaria muralis	AM	260, 261
Digitalis purpurea	AM + NM	260, 261
Eremophila longifolia	Weak AM	438
Eremophila macdonnellii	Weak AM	438
Euphrasia minima	NM	260, 261
Euphrasia officinalis s. l.	NM	260, 261
Euphrasia stricta	NM	456
Kickxia spuria	AM	260, 261
Lamourouxia rhinanthifolia	NM	103
Linaria repens	AM + NM	260, 261
Linaria supina	AM + NM	260, 261
Linaria vulgaris	AM + NM	260, 261
Melampyrum arvense	NM	260, 261
Melampyrum cristatum	NM	260, 261
Melampyrum pretense	NM	194
	AM + NM	260, 261
Melampyrum sylvaticum	NM	194, 260, 261
Mimulus guttatus	NM	62
	AM	95
Mimulus ringens	AM	140
Odontites lutea	AM	368
Odontites verna	NM	260, 261
Pedicularis capitata	NM	594
Pedicularis kanei	NM	594
Pedicularis langsdorffii	NM	594
Pedicularis palustris	NM	260, 261
Pedicularis sylvatica	NM	260, 261
Pedicularis verticillata	NM	594
Penstemon cardwellii	Facultative AM	585
Penstemon frutescens	Facultative AM	587
Plantago asiatica	AM	643
Rhinanthus angustifolius	AM	456
	NM	260, 261
Rhinanthus minor	Weak AM	194
Scrophularia auriculata	AM	260, 261
Scrophularia nodosa	AM + NM	260, 261
Scrophularia umbrosa	NM	260, 261
Scrophularia vernalis	NM	260, 261

Examined species[a]	Mycorrhizal status[b,c]	References
Verbascum lychnitis	AM	260, 261
Verbascum nigrum	AM	260, 261
Verbascum thapsus	AM	207, 260, 261
Veronica agrestis	AM + NM	260, 261
Veronica alpina	AM	260, 261
Veronica	Facultative AM	62
anagallis-aquatica	AM	260, 261
Veronica arvensis	AM	643, 260, 261
Veronica beccabunga	NM	62, 260, 261
Veronica chamaedrys	AM	194, 456
	AM + NM	260, 261
Veronica filiformis	AM	260, 261
Veronica fruticans	AM	260, 261
Veronica officinalis	AM	194
	AM + NM	260, 261
Veronica peregrina	AM	260, 261
Veronica persica	AM	643, 260, 261
Veronica serpyllifolia	AM	194, 260, 261
Veronica spicata	AM	260, 261
Lentibulariaceae		
Pinguicula alpine	NM	260, 261
Pinguicula vulgaris	NM	260, 261
Convolvulaceae		
Calystegia sepium	AM	260, 261
Calystegia soldanella	NM	368
Convolvulus arvensis	AM	260, 261
Convolvulus elegantissimus	AM	472
Convolvulus eyreanus	AM	438
Ipomoea arborescens	Weak AM	103
Ipomoea batatas	AM	455
Ipomoea imperati	AM	326
Ipomoea pes-caprae	AM	64, 65, 144, 326, 336
Ipomoea stolonifera	Weak AM	143
Jacquemontia ovalifolia	AM	326
Jacquemontia reclinata	AM	202
Solanaceae		
Atropa belladonna	AM	260, 261
Capsicum annuum	AM	50
Cestrum intermedium	AM	651
Datura metal	AM	216
Datura stramonium	AM	343
Lycium barbarum	AM	260, 261
Lycium fremontii	AM	112
Lycium sandwicense	AM	326
Lycopersicon esculentum	AM	407
Nicotiana velutina	AM	438
Petunia × hybrida	AM	322
Solanum argenteum	AM	651
Solanum dulcamara	NM	62
	AM	260, 261
Solanum elipticum	AM	438
Solanum khasianum	AM	343
Solanum hindsianum	AM	112
Solanum nigrum	AM + NM	260, 261
Solanum surattense	AM	567
Solanum torvum	NM	422
Solanum tuberosum	AM	386
Aquifoliaceae		
Ilex aquifolium	AM + ECM	260, 261
Ilex paraguariensis	AM	31
Ilex verticallata	AM	140
Araliaceae		
Didymopanax angustissimum	AM	31
Hedera helix	AM	368, 472, 260, 261
Macropanax dispermus	AM	655
Panax ginseng	AM	178
Panax quinquefolius	AM	390
Pseudopanax laetevirens	AM	207
Stilbocarpa polaris	NM	342
Trevesia palmata	NM	422
Trevesia palmata var. costata	NM	655
Pittosporaceae		
Pittosporum gayanum	AM	326
Apiaceae		
Actinotis helianthi	AM	67
Aegopodium podograria	AM + NM	260, 261
Aethusa cynapium	AM	260, 261
Angelica archangelica	AM	260, 261
Angelica sylvestris	AM	260, 261
Anthriscus sylvestris	NM	260, 261
Apium graveolens	AM	490, 260, 261
Apium nodiflorum	NM	260, 261
Astrantia major	AM + NM	260, 261
Azorella macquariensis	AM	342
Berula erecta	Facultative AM	62
	NM	260, 261
Bupleurum baldense	AM	472
Bupleurum falcatum	AM	260, 261
Carum carvi	AM	194, 260, 261
Chaerophyllum temulentum	AM + NM	260, 261
Conium maculatum	AM	260, 261
Conopodium majus	AM	260, 261
Coriandrum sativum	AM	220
Daucus carota	AM	171
	AM + NM	260, 261
Echinophora spinosa	AM	368
Eryngium campestre	AM	260, 261
Eryngium maritimum	AM	368
	AM + NM	260, 261
Eryngium paniculatum	AM	207
Foeniculum vulgare	AM	305
Heracleum sphondylium	AM + NM	260, 261

Examined species[a]	Mycorrhizal status[b,c]	References
Hydrocotyle bonariensis	AM	143
Hydrocotyle novae-zeelandiae	AM	342
Hydrocotyle vulgaris	AM	368
	AM + NM	260, 261
Myrrhis odorata	AM	260, 261
Oenanthe aquatica	NM	260, 261
Oenanthe crocata	NM	260, 261
Osmorhiza chilensis	AM	207
Pastinaca sativa	AM	307, 260, 261
Petroselium crispum	AM	171
	NM	260, 261
Peucedanum ostruthium	AM	260, 261
Peucedanum palustre	AM	260, 261
Pimpinella major	AM + NM	260, 261
Pimpinella saxifraga	AM	194, 456
	AM + NM	260, 261
Platysace linearifolia	ECM	67
Sanicula europaea	AM	260, 261
Scandix pecten-veneris	AM	260, 261
Seseli libanotis	AM	260, 261
Seseli tortuosum	AM	368
Silaum silaus	AM	260, 261
Sium latifolium	NM	260, 261
Trachymene glaucifolia	AM	438
Campanulaceae		
Brighamia insignis	AM	326
Campanula glomerata	AM	260, 261
Campanula lasiocarpa	AM	587
Campanula patula	AM	260, 261
Campanula persicifolia	AM	194
	AM + NM	260, 261
Campanula punctata ssp.hondoensis	AM	636
Campanula rapunculoides	AM	260, 261
Campanula rotundifolia	AM	194, 437, 456, 260, 261
Campanula trachelium	NM	260, 261
Clermontia fauriei	AM	326
Cyanea leptostegia	AM	326
Downingia elegans	AM	293
Jasione montana	AM + NM	260, 261
Lobelia cardinalis	AM	140
Lobelia dortmanna	AM	62, 432, 260, 261
Lobelia sp.	AM + ECM	656
Lobelia yuccoides	AM	326
Phyteuma orbiculare	AM	260, 261
Phyteuma spicatum	AM + NM	260, 261
Pratia nummularia	AM	422
Trematolobelia kauaiensis	AM	326
Menyanthaceae		
Menyanthes trifoliata	NM	260, 261
Nymphoides peltata	NM	260, 261
Goodeniaceae		
Calogyne sp.	AM + ECM	656
Dampiera stricta	AM + ECM	67
Goodenia cycloptera	AM	438
Goodenia lunata	AM	438
Goodenia sp.	AM + ECM	656
Scaevola chamissoniana	AM	326
Scaevola gaudichaudii	AM	326
Scaevola parvibarbata	AM	438
Scaevola procera	AM	326
Scaevola sericea	AM	326
Asteraceae		
Achillea millefolium	AM	194
	AM + NM	260, 261
Achillea ptarmica	AM	194
	NM	260, 261
Ageratina espinosarum	Weak AM	103
Ageratum conyzoides	AM	336, 422
Ambrosia artemisifolia	AM	143
Anaphalis margaritacea	Facultative AM	585
	AM	260, 261
Angianthus sp.	AM + ECM	656
Antennaria dioica	AM	194, 260, 261
Anthemis arvensis	AM	260, 261
Anthemis tinctoria	AM	260, 261
Arctium lappa	AM + NM	260, 261
Arctium minus s. l.	AM	260, 261
Arnica angustifolia	AM	443
Arnica montana	AM	194, 269
Artemisia absinthium	NM	260, 261
Artemisia californica	AM	646
Artemisia campestris	AM	260, 261
Artemisia codonocephala	AM	343
Artemisia dracunculus	AM	105
Artemisia ludoviciana	AM	633
Artemisia maritima	AM + NM	260, 261
Artemisia princeps	AM	643
Artemisia tridentata	AM	183
Artemisia tridentata ssp. wyomingensis	AM	552
Artemisia vulgaris	AM	307, 260, 261
Aster novi belgii	AM	260, 261
Aster sericeus	AM	633
Aster subulatus	AM	326
Aster tripolium	AM	113, 518, 260, 261
Baccharis racemosa	AM	207
Balduina angustifolia	AM	30
Bebbia juncea	AM	112
Bellis perennis	AM + NM	260, 261
Berkheya coddii	AM	597

Examined species[a]	Mycorrhizal status[b,c]	References
Bidens asymmetrica× sandvicensis	AM	227
Bidens bipinnata	AM	422
Bidens cosmoides	AM	326
Bidens frondosa	AM	140, 368
Bidens pilosa	AM	143, 343, 422
Bidens sandwicensis	AM	227, 326
Bidens tripartita	AM	140
	AM + NM	260, 261
Blainvillea acmella	AM	343
Calendula officinalis	AM	260, 261
Callistephus chinensis	AM	428
Carduus acanthoides	AM	307, 260, 261
Carlina vulgaris	AM	456, 260, 261
Carthamus tinctorius	AM	94
Centaurea cyanus	AM	260, 261
Centaurea jacea	AM	194, 260, 261
Centaurea maculosa	AM	109, 371
Centaurea nigra	AM	260, 261
Centaurea pratensis	AM	260, 261
Centaurea scabiosa	AM	260, 261
Centaurea subciliata	AM	368
Chrysanthemum morifolium	AM	551
Chrysanthemum segetum	AM	260, 261
Cicerbita alpina	AM + NM	260, 261
Cichorium intybus	AM	260, 261
Cirsium acaule	AM	260, 261
Cirsium arvense	AM	307, 260, 261
Cirsium helenioides	AM	260, 261
Cirsium oleraceum	AM	260, 261
Cirsium palustre	AM + NM	260, 261
Cirsium purpuratum	AM	636
Cirsium setosum	AM	620
Cirsium vulgare	AM	626
	AM + NM	260, 261
Conyza blinii	AM	343
Conyza canadensis	AM	326, 343
Cotula plumose	NM	342, 560
Crassocephalum crepidioides	AM	422
Crepis biennis	AM	260, 261
Crepis capillaris	AM	260, 261
Crepis paludosa	AM + NM	260, 261
Crepis praemorsa	AM	194
Crepis setosa	AM	207
Cynara cardunculus	AM	369
Dittrichia viscosa	AM	497
Dubautia ciliolata	AM	326
Dubautia knudseni	AM	326
Dubautia plantaginea	AM	326
Dubautia scabra	AM	326
Eclipta alba	AM	577

Examined species[a]	Mycorrhizal status[b,c]	References
Emilia sonchifolia	AM	326, 336
Erechtites hieracifolia	AM	326
Ericameria diffusa	AM	112
Erigeron acer	NM	260, 261
Erigeron annuus	AM	643
Erigeron bonariensis	AM	643
Erigeron borealis	AM	260, 261
Erigeron canadensis	AM	294
	AM + NM	260, 261
Eriophyllum lanatum	AM	293
Eupatorium cannabinum	AM	260, 261
Eupatorium coelesticum	AM	422
Eupatorium maculatum	AM	140
Eupatorium odoratum	AM	422
Eupatorium perfoliatum	AM	140
Eupatorium serotinum	AM	599
Filaginella uliginosa	AM	194
Florestina tripteris	AM	143
Flourensia cernua	AM	137
Galinsoga ciliata	AM	260, 261
Galinsoga parviflora	AM	260, 261
Galinsoga supinum	AM	260, 261
Galinsoga sylvaticum	AM	260, 261
Galinsoga uliginosum	AM	260, 261
Gnaphalium norvegicum	AM	502, 503, 260, 261
Gnephosis eriocarpa	Weak AM	438
Gutierrezia sarothrae	AM	492, 493
Gymnosperma glutinosum	Weak AM	103
Haplopappus venetus	AM	543
Helianthus annuus	AM	121, 260, 261
Helianthus niveus	AM	543
Helichrysum italicum	AM	368
Helichrysum sp.	AM + ECM	656
Helichrysum stoechas	AM	368
Helipterum sp.	AM + ECM	656
Hieracium albiflorum	Facultative AM	585
Hieracium alpinum	AM	260, 261
Hieracium bifidum	AM	260, 261
Hieracium lachenalii	AM	260, 261
Hieracium lactucella	AM	194
Hieracium laevegatum	AM + NM	260, 261
Hieracium murorum	AM + NM	260, 261
Hieracium pilosella	AM	270, 456, 260, 261
Hieracium sagittatum	AM	260, 261
Hieracium subaundum	AM	260, 261
Hieracium umbellatum	AM	194, 260, 261
Hieracium vulgatum	AM + NM	260, 261
Homogyne alpina	AM + ECM	260, 261
Hypochaeris radicata	Facultative AM	584, 585, 260, 261
Hypochoeris achyrophorus	AM	472

Examined species[a]	Mycorrhizal status[b,c]	References
Inula conyza	AM	260, 261
Inula salicina	AM	260, 261
Ixeris denticulate	AM	129
Jaumea carnosa	AM	90
Lactuca hirsuta	AM	140
Lactuca sativa	AM	40, 171, 500
Laggera pterodonta	AM	343
Lapsana communis	AM	260, 261
Launaea sarmentosa	AM	336
Leontodon autumnalis	AM	194, 260, 261
Leontodon hispidus	AM	260, 261
Leontodon hispidus ssp. danubialis	AM	456
Leontodon hispidus ssp. hispidus	AM	456
Leucanthemum vulgare	AM	194, 260, 261
Leuceria achillaeifolia	NM	207
Liatris tenuifolia var. laevigata	Weak AM	30
Lipochaeta connata	AM	326
Matricaria maritime ssp. inodora	AM	307
Matricaria matricarioides	AM	260, 261
Matricaria recutita	AM + NM	260, 261
Microseris laciniata	AM	293
Mutisia decurrens	AM	207
Mutisia spinosa	AM	207
Mycelis muralis	AM + ECM + NM	260, 261
Omalotheca norvegica	AM	194
Onopordum acanthium	AM + NM	260, 261
Otanthus maritimus	AM	368
Othonna gregorii	AM + NM	438
Palafoxia lindenii	AM	144
Parthenium argentatum	AM	461
Parthenium hysterophorus	AM	343
Pectis saturejoides	AM	143
Petasites albus	AM + NM	260, 261
Petasites frigidus	NM	594
Petasites hybridus	AM + NM	260, 261
Phagnalon rupestre	AM	472
Picris echioides	AM	260, 261
Picris hieracioides	AM	260, 261
Piptocarpha axillaris	AM	651
Pityopsis graminifolia	Weak AM	30
Pleurophyllum hookeri	AM	342
Podolepis sp.	AM + ECM	656
Polycalymma stuartii	AM	438
Porophyllum numularium	AM	143
Pulicaria angustifolia	AM	567
Pulicaria dysenterica	AM	260, 261
Remya kauaiensis	AM	326
Rhodanthe floribunda	AM	438
Rhodanthe moschata	AM	438

Examined species[a]	Mycorrhizal status[b,c]	References
Sagittaria latifolia	AM	58, 626
Sanvitalia procumbens	AM	260, 261
Saussurea alpina	AM	260, 261
Scorzonera humilis	AM	194
Senecio articulatus	AM	417
Senecio bicolor	AM	368, 260, 261
Senecio bracteolatus	AM	207
Senecio erucifolius	AM	260, 261
Senecio jacobaea	AM + NM	260, 261
Senecio pendulus	AM	417
Senecio praecox	AM	208
	NM	103
Senecio squalidus	AM	260, 261
Senecio sylvaticus	AM + NM	260, 261
Senecio viscosus	AM	307, 260, 261
Senecio vulgaris	AM	625
	AM + NM	260, 261
Serratula tinctoria	AM	212, 260, 261
Siegesbeckia orientalis	AM	343
Solidago altissima	AM	643
Solidago canadensis	AM	298, 626
Solidago chilenesis	AM	207
Solidago gigantea	AM	140
Solidago graminifolia	AM	140
Solidago litoralis	AM	368
Solidago sp.	AM	58
Solidago virgaurea	AM	194, 260, 261
Sonchus arvensis	AM	302
	AM + NM	260, 261
Sonchus asper	AM + NM	260, 261
Sonchus oleraceus	AM	343, 643, 260, 261
Spilanthes callimorpha	AM	422
Synedrella nudiflora	AM	422
Tagetes erecta	AM	2, 102, 350
Tagetes patula	AM	322, 350, 554
Tagetes tenuifolia	AM	350
Tanacetum parthenium	NM	260, 261
Tanacetum vulgare	AM + NM	260, 261
Taraxacum japonicum	AM	643
Taraxacum officinale	AM	307
Tithonia diversifolia	AM	422, 539
Tragopogon pratensis	AM	260, 261
Tridax procumbens	AM	336
Tripleurospermum inodorum	AM	260, 261
Tripleurospermum maritimum	AM	260, 261
Tussilago farfara	AM	307
	AM + NM	260, 261
Verbesina encelioides	AM	326
Vernonia noveboracensis	AM	140
Viguiera eriophora	AM	103

Examined species[a]	Mycorrhizal status[b,c]	References
Waitzia sp.	AM + ECM	656
Wedelia trilobata	AM	326
Wilkesia gymnoxiphium	AM	326
Xanthium sibiricum	AM	343
Xanthocephalum microcephala	AM	137
Zinnia acerosa	AM	137
Zinnia elegans	AM	2, 343
Adoxaceae		
Adoxa moschatellina	NM	260, 261
Caprifoliaceae		
Carlemannia tetragona	AM	655
Linnaea borealis	AM	260, 261
Lonicera caprifolium	AM	260, 261
Lonicera implexa	AM	368
Lonicera pericylmenum	AM	260, 261
Lonicera xylosteum	AM + NM	260, 261
Sambucus nigra	AM + NM	260, 261
Sambucus racemosa	AM + ECM+NM	260, 261
Symphoricarpos rivularis	AM + NM	260, 261
Viburnum lantana	AM	260, 261
Viburnum lentago	AM	140
Viburnum opulus	AM	260, 261
Viburnum tinus	AM	368
Dipsacaceae		
Dipsacus fullonum	AM + NM	260, 261
Knautia arvensis	AM	194, 260, 261
Pycnocomon rutifolium	AM	368
Scabiosa columbaria	AM	260, 261
Scabiosa ochroleuca	AM	456
Succisa pratensis	AM	194, 260, 261
Valerianaceae		
Centranthus ruber	NM	260, 261
Valeriana dioica	NM	260, 261
Valeriana laxiflorac	AM	207
Valeriana officinalis	AM + NM	260, 261
Hamamelidaceae		
Liquidambar styraciflua	AM	139
Crassulaceae		
Aeonium decorum	AM	417
Crassula aquatica	NM	260, 261
Crassula moschata	NM	342, 560
Crassula phyturus	AM	417
Crassula rupestris	AM	417
Echeveria sedoides	NM	417
Kalanchoe daigremontana	AM	417
Sedum acre	AM + NM	260, 261
Sedum adolfii	AM	417
Sedum album	NM	260, 261
Sedum dasyphyllum	NM	260, 261
Sedum forsteranum	NM	260, 261
Sedum reflexum	NM	260, 261
Sedum rosea	AM + NM	260, 261
Sedum telephium	NM	260, 261
Sempervivum tectorum	M(endo) + NM	260, 261
Haloragaceae		
Myriophyllum alterniflorum	NM	260, 261
Proserpinaca palustris	AM	140
Grossulariaceae		
Ribes alpinum	AM + ECM + NM	260, 261
Ribes magellanicum	AM	207
Ribes nigrum	AM	260, 261
Ribes rubrum	AM	260, 261
Ribes uva-crispa	AM	260, 261
Saxifragaceae		
Chrysosplenium alternifolium	AM + NM	260, 261
Chrysosplenium oppositifolium	NM	260, 261
Saxifraga aizoides	AM + NM	260, 261
Saxifraga granulate	AM	194
	AM + NM	260, 261
Saxifraga hieracifolia	NM	594
Saxifraga hirculus	NM	594
Saxifraga oppositifolia	AM + NM	260, 261
Saxifraga stellaris	NM	260, 261
Vitaceae		
Cayratia japonica	AM	643
Leea compactiflora	AM	655
Leea indica	AM	655
Leea marcophylla	AM	655
Vitis vinifera	AM	306, 517
Geraniaceae		
Erodium cicutarium	AM + NM	260, 261
Erodium crinitum	AM	438
Geranium carolinianum	AM	643
Geranium dissectum	AM	260, 261
Geranium lucidum	AM + NM	260, 261
Geranium molle	AM + NM	260, 261
Geranium nodosum	AM	260, 261
Geranium pratense	AM	260, 261
Geranium robertianum	AM	262, 472
	AM + NM	260, 261
Geranium sanguineum	NM	260, 261
Geranium sessiliflorum	AM	207
Geranium sylvaticum	AM	194, 260, 261
Pelargonium hortorum	AM	435
Combretaceae		
Terminalia catappa	AM	326
Terminalia superba	AM	445
Onagraceae		
Camissonia californica	AM	543
Chamerion angustifolium	AM + NM	260, 261
Circaea alpina	AM	260, 261
Circaea lutetiana	AM	260, 261

Examined species[a]	Mycorrhizal status[b,c]	References
Epilobium alsinifolium	AM + NM	260, 261
Epilobium anagallidifolium	AM	260, 261
Epilobium angustifolium	Facultative AM	585
Epilobium brunnescens ssp. brunnescens	NM	342
Epilobium ciliatum	AM	260, 261
Epilobium coloratum	AM	140
Epilobium hirsutum	Facultative AM	62
	AM	260, 261
Epilobium lanceolatum	AM	260, 261
Epilobium montanum	AM + NM	260, 261
Epilobium obscurum	AM	260, 261
Epilobium palustre	AM	260, 261
Epilobium parviflorum	AM	260, 261
Epilobium pendunculare	AM	342
Epilobium roseum	AM	260, 261
Epilobium tetragonum	AM	260, 261
Ludwigia palustris	AM	140
Ludwigia prostrata	AM	422
Oenothera biennis	AM	260, 261
Oenothera erythrosepala	AM	260, 261
Lythraceae		
Cuphea carthagenensis	AM	326
Lafoensia pacari	AM	651
Lythrum alatum	AM	599
Lythrum hyssopifolia	NM	260, 261
Lythrum maritimum	AM	326
Lythrum salicaria	AM	140, 462, 558, 629
	AM + NM	260, 261
Myrtaceae		
Acca sellowiana	AM	31
Acmena resa	AM	222
Angophora hispida	ECM	67
Baeckea ramosissima	ECM	67
Campomanesia xanthocarpa	AM	651
Eucalyptus bosistoana	AM	5
Eucalyptus camaldulensis	AM + ECM	179
Eucalyptus citriodora	AM	343
	AM + ECM	179
Eucalyptus cloeziana	AM + ECM	179
Eucalyptus delegatensis	AM	5
Eucalyptus dives	AM	5
Eucalyptus dumosa	Weak AM	5
Eucalyptus dunnii	AM + ECM	442
Eucalyptus globoidea	ECM	133
Eucalyptus globulus	AM	5
	ECM	359
Eucalyptus globulus ssp. bicostata	ECM	12
Eucalyptus gomphocephala	AM	5

Examined species[a]	Mycorrhizal status[b,c]	References
Eucalyptus grandis	AM + ECM	179
	ECM	96
Eucalyptus haemostoma	ECM	67
Eucalyptus largiflorens	AM	5
Eucalyptus macarthurii	AM	5
Eucalyptus marginata	ECM	365
Eucalyptus microcorys	ECM	120
Eucalyptus racemosa	ECM	67
Eucalyptus regnans	ECM	341
Eucalyptus sieberi	ECM	133
Eucalyptus stricta	ECM	67
Eucalyptus torelliana	ECM	120
Eucalyptus urophylla	AM	5
	AM + ECM	179
Eucalyptus viminalis	AM	5
	AM + ECM	66
Eucalyptus viridis	AM	5
Eugenia uniflora	AM	651
Gomidesia spectabilis	AM	31
Kunzea capitata	ECM	67
Leptospermum flavescens	ECM	67
Leptospermum lanigerum	ECM	67
Luma apiculata	AM	207
Melaleuca quinquenervia	AM + ECM	316
Metrosideros polymorpha	AM	326
Myrtus communis	AM	368, 382, 472
Plinia rivularis	Weak AM	651
Psidium cattleianum	AM	326
Psidium guajava	AM	31, 198, 337
Rhodomyrtus tomentosa	AM	326
Syzygium firmum	AM	215
Syzygium guineense	AM	637, 638
Syzygium jambolanum	AM	548
Syzygium latilimbum	AM	422
Syzygium makul	AM	215
Syzygium operculatum	AM	215
Syzygium rubicundum	AM	215
Tristaniopsis whiteana	NM	568
Melastomataceae		
Clidemia hirta	AM	326
Graffenrieda emarginata	AM + ECM	266
Leandra dasytricha	AM	31
Melastoma affine	NM	422
Melastoma melabathricum	AM	568
Krameriaceae		
Krameria paucifolia	AM	112
Zygophyllaceae		
Balanites aegyptiaca	AM	47
Fagonia cretica	AM	567
Larrea tridentata	AM	112, 137
Morkillia mexicana	Weak AM	103
Tribulus cistoides	NM	326
Tribulus terrestris	AM	343

Examined species[a]	Mycorrhizal status[b,c]	References
Viscainoa geniculata	AM	112
Zygophyllum dumosum	AM	268
Zygophyllum howittii	NM	438
Parnassiaceae		
Parnassia palustris	AM + NM	260, 261
Celastraceae		
Euonymus europaeus	AM	260, 261
Maytenus boaria	AM	207
Maytenus chubutensis	AM	207
Maytenus magellanica	AM	207
Maytenus phyllantoides	AM	112
Humiriaceae		
Sacoglottis gabonensis	AM	445
Pandaceae		
Panda oleosa	AM	445
Rhizophoraceae		
Combretocapus rotundatus	NM	568
Poga oleosa	AM	445
Linaceae		
Linum bienne	AM	472
Linum catharticum	AM	456
	AM + NM	260, 261
Linum perenne ssp. anglicum	NM	260, 261
Linum strictum	AM	472
Linum trigynum	AM	472
Linum usitatissimum	AM	171, 180
	AM + NM	260, 261
Erythroxylaceae		
Erythroxylon compactum	NM	103
Euphorbiaceae		
Acalypha acmophylla	AM	343
Actinostemon concolor	AM	651
Adelia virgata	AM	112
Alchornea cordifolia	AM	445
Alchornea tiliaefolia	AM	422, 655
Aleurites moluccana	AM	326
Amperea xiphoclada	ECM	67
Baccaurea ramiflora	AM	422, 655
Breynia fruticosa	AM	422
Celaenodendron mexicanum	AM	20
Chamaesyce atrococca	AM	326
Chamaesyce celastroides	AM	326
Chamaesyce degeneri	AM	326
Chamaesyce hypericifolia	AM	326
Cleidion bracteosum	AM	422
Cleidion brevipetiolatum	AM	655
Cleistanthus sumatranus	AM	422
	NM	655
Croton ciliato-glanduliferus	Weak AM	103
Croton floribundus	AM	651
Croton kongensis	AM	422
Croton machrostachyus	AM	637, 638
Croton punctatus	AM	143
Croton urucurana	AM	651
Ditaxis lanceolata	AM	112
Drypetes gossweileri	AM	445
Drypetes hoaensis	NM	655
Epiprinus silhetianus	NM	655
Euphorbia amygdaloides	AM	260, 261
Euphorbia cyparissias	AM	260, 261
Euphorbia dulcis	AM	260, 261
Euphorbia esula	AM	260, 261
Euphorbia gatbergensis	AM	417
Euphorbia helioscopia	AM + NM	260, 261
Euphorbia heterophylla	AM	343
Euphorbia hirta	AM	216, 343
	Facultative AM	422
Euphorbia lathyrus	AM	260, 261
Euphorbia paralias	AM	260, 261
Euphorbia parliramulosa	AM	417
Euphorbia peplis	AM	368
Euphorbia peplus	AM	472
	AM + NM	260, 261
Euphorbia royleana	AM	343
Euphorbia tannensis	AM	438
Euphorbia thymifolia	AM	343
Glochidion assamicum	NM	655
Hevea brasiliensis	AM	288, 526, 527
Hieronyma alchorneoides	AM	31
Jatropha cinerea	AM	112
Jatropha cuneata	AM	112
Macaranga denticulata	AM	422, 648
Macaranga indica	AM	655
Macaranga peltata	AM	315
Manihot esculanta	AM	252
Mercurialis annua	AM	260, 261
Mercurialis perennis	AM + NM	260, 261
Pedilanthus cymbiferus	NM	103
	AM	112
Pedilanthus macrocarpus	AM	112
Phyllanthus asteranthus	AM	422
Phyllanthus lacunarius	AM	438
Phyllanthus niruri	AM	577
Phyllanthus urinaria	AM	343
Ricinodendron heudelotii	AM	445
Ricinus communis	AM	318
Sauropus androgynus	AM	253
Sebastiania commersoniana	AM	651
Uapaca acuminata	AM + ECM	445
Uapaca guineense	ECM	52, 445
Uapaca heudelotti	AM	52

Examined species[a]	Mycorrhizal status[b,c]	References
Uapaca staudtii	ECM+AM	413
	ECM	445
Uapaca vanhouttei	ECM	445
Violaceae		
Viola arvensis	AM + NM	260, 261
Viola calaminaria	AM	588
Viola canina	AM	269
	AM + NM	260, 261
Viola hirta	AM	260, 261
Viola kitaibeliana	AM + NM	260, 261
Viola lutea	AM	260, 261
Viola maculata	AM	207
Viola odorata	AM	260, 261
Viola palustris	AM + NM	260, 261
Viola reichenbachiana	AM + NM	260, 261
Viola riviniana	AM	260, 261
Viola rupestris	AM	260, 261
Viola tricolor	AM	194, 456
	AM + NM	260, 261
Viola wailenalenae	AM	326
Viola × wittrockiana	AM	322
Salicaceae		
Casearia sylvestris	AM	31, 651
Populus alba	ECM+AM	368
	ECM+NM	260, 261
Populus balsamifera	ECM	470
Populus balsamifera ssp. trichocarpa	ECM	271
Populus × canadensis	AM + ECM	260, 261
Populus canescens	ECM	260, 261
Populus deltoides	AM	140
Populus euroamericana	AM + ECM	317
Populus nigra	AM + ECM	260, 261
Populus nigra 'Italica'	AM + ECM	260, 261
Populus serotina	AM + ECM	260, 261
Populus tremula	AM + ECM	260, 261
Populus tremula× tremuloides	ECM	59
Populus tremuloides	ECM	145, 338
	ECM+AM	430
Populus trichocarpa	ECM	59, 260, 261
Salix alba	ECM	260, 261
Salix alba vitellina	ECM	260, 261
Salix arbuscula	ECM	260, 261
Salix arctica	ECM	594
Salix aurita	ECM+NM	260, 261
Salix babylonica	AM + ECM	316, 260, 261
Salix caprea	AM + ECM	260, 261
Salix cinerea	AM + ECM	260, 261
Salix daphnoides	ECM	260, 261
Salix fragilis	ECM	260, 261
Salix gracilistyla	AM	511
Salix herbacea	ECM+EEM	260, 261
Salix lapponum	ECM	260, 261
Salix myrsinites	ECM	260, 261
Salix nigra	AM	140
Salix nigricans	ECM+NM	260, 261
Salix phylicifolia	ECM	260, 261
Salix polaris	ECM	594
Salix purpurea	AM + ECM	260, 261
Salix reinii	ECM	587
Salix repens	AM	605
	AM + ECM	260, 261
Salix reticulata	ECM	594, 260, 261
Salix triandra	ECM	260, 261
Salix viminalis	AM	60
	AM + ECM	260, 261
Xylosma ciliatifolium	AM	651
Xylosma pseudosalzmannii	AM	651
Turneraceae		
Turnera ulmifolia	AM	143
Clusiaceae		
Calophyllum sclerophyllum	AM	568
Calophyllum soulattri	AM	568
Clusia minor	AM	474
Clusia rotundata	AM	474
Cratoxylum arborescens	AM	568
Garcinia cowa	NM	655
Garcinia kola	AM	445
Garcinia lucida	AM	445
Garcinia xanthochymus	Facultative AM	422
Hypericaceae		
Hypericum calycinum	NM	260, 261
Hypericum hirsutum	NM	260, 261
Hypericum humifusum	NM	260, 261
Hypericum maculatum	AM	194, 260, 261
Hypericum montanum	NM	260, 261
Hypericum perforatum	AM	409, 260, 261
Hypericum pulchrum	AM	260, 261
Hypericum tetrapterum	AM + NM	260, 261
Elatinaceae		
Elatine hexandra	AM	62
Ochnaceae		
Lophira alata	AM	445
Chrysobalanaceae		
Licania platypus	AM	321
Oxalidaceae		
Oxalis acetosella	AM	598
	AM + NM	260, 261
Oxalis corniculata	AM	294, 643, 260, 261
Oxalis corymbosa	AM	643
Oxalis exilis	AM	260, 261
Oxalis europaea	AM	260, 261
Oxalis stricta	AM	260, 261
Oxalis valdiviensis	AM	207

Examined species[a]	Mycorrhizal status[b,c]	References
Cunoniaceae		
Ceratopetalum apetalum	AM	387
	ECM	389
Elaeocarpaceae		
Aristotelia chilensis	AM	207
Elaeocarpus austro-yunnanensis	AM	422
Sloanea guianensis	AM	31
Polygalaceae		
Polygala nicaeensis	AM	368
Polygala amarella	AM + NM	260, 261
Polygala calcarea	AM	260, 261
Polygala serpyllifolia	AM	260, 261
Polygala vulgaris	AM	194
	AM + ECM	260, 261
Salomonia sp.	Mycoheterotrophy via AM	658
Fabaceae		
Acacia albida	AM	174
Acacia ampliceps	AM	477
Acacia arabica	AM	317
Acacia auriculiformis	AM	52, 229
Acacia bonariensis	AM + ECM	211
Acacia caven	AM	211
Acacia cochliacantha	Weak AM	103
Acacia constricta	Weak AM	103
Acacia eriopoda	AM	477
Acacia farnesiana	AM	343, 600
	Weak AM	103
Acacia holosericea	ECM	186
Acacia koa	AM	326, 406
Acacia leptocarpa	AM	52
Acacia linifolia	AM	68
	ECM+AM	67
Acacia mangium	ECM	186, 187
	AM	52, 257, 520
Acacia nilotica	AM	473, 538
Acacia obtusifolia	ECM+AM	67
Acacia pennatula	AM	18
Acacia polyphylla	AM	651
Acacia suaveolens	ECM+AM	67
Acacia tortilis	AM	567
Acacia ulicifolia	ECM+AM	67
Adenanthera pavonina	AM	52
Aeschynomene indica	AM	546
Afzelia africana	NM	47
	ECM	45, 52
Afzelia bipidensis	ECM+AM	413, 445
Afzelia pachyloba	AM + ECM	445
Afzelia quanzensis	ECM	418
Albizia corniculata	AM	655
Albizia falcataria	AM	14
Albizia ferruginea	AM	52, 256
Albizia gummifera	AM	637, 638
Albizia hassleri	AM	651
Albizia kalkora	AM	343
Albizia lebbeck	AM	52, 216, 477, 538, 548
Albizia schimperiana	AM	637, 638
Alysicarpus regosus	AM	336
Alysicarpus vaginalis	AM	343
Amorpha crenulata	AM	202
Amphimas ferrugineus	AM	445
Amphimas pterocarpoides	AM	52, 445
Anadenanthera colubrina	AM	452, 651
Anadenanthera falcata	AM	548
Anadenanthera macrocarpa	AM	651
Anadenanthera peregrina	AM	528, 593
Anthonotha fragrans	ECM	52
	ECM+AM	413, 445
Anthonotha macrophylla	ECM	52, 413, 445
Anthyllis cytisoides	AM	170, 234, 583
Anthyllis tetraphylla	AM	472
Anthyllis vulneraria	AM	456
	AM + NM	260, 261
Aphanocalyx cynometroides	ECM	413
Arachis hypogaea	AM	111
Astragalus alpinus	NM	594
Astragalus applegatei	AM	55
Astragalus glycyphyllos	NM	260, 261
Atylosia scarabaeoides	AM	343
Baphia nitida	AM	52
Bauhinia forficata	AM	211, 651
Berlinia bracteosa	ECM	445
Berlinia confusa	ECM	52, 445
Bossiaea obcordata	AM	67
Brachystegia cynometroides	ECM	445
Brachystegia eurycoma	ECM	445
Brachystegia leonensis	ECM	52
Brachystegia zenkeri	ECM	445
Bussea occidentalis	AM	52
Caesalpinia eriostachys	AM	20
Caesalpinia ferrea	AM	548
Caesalpinia gilliesii	AM	211
Caesalpinia pannosa	AM	112
Caesalpinia peltophoroides	AM	548
Cajanus cajan	AM	172, 624
Calliandra eriophylla	Weak AM	103
Calliandra parvifolia	Weak AM + ECM	211
Calliandra selloi	AM	211
Calliandra tweedii	AM + ECM	211
Calopogonium caeruleum	AM	289
Calopogonium mucunoides	AM	439

Examined species[a]	Mycorrhizal status[b,c]	References
Canavalia rosea	AM	144, 336
Cassia grandis	AM	548
Cassia siamea	AM	52, 230, 251
Cassia spectabilis	AM	258
Castanospermum australe	AM	4
Cathormion polyanthum	AM	211
Centrolobium tomentosum	AM	372, 651
Ceratonia siliqua	AM	147
Cercidium praecox	AM	112
Chamaecrista chamaecristoides	AM	143
Cicer arietinum	AM	124, 125
Colophospermum mopane	AM	477
Copaifera langsdorffii	AM	548, 651
Cordyla pinnata	AM	47
Coronilla emerus ssp. emeroides	AM	368
Coronilla scorpioides	AM	472
Coronilla varia	AM	159
	NM	260, 261
Crotalaria burhia	AM	567
Crotalaria incana	AM	143
Crotalaria medicaginea	AM	343, 567
Cullen discolor	AM	438
Cullen pallida	AM	438
Cylicodiscus gabunensis	AM	445
Cynometra alexandri	AM	591
Cynometra leonensis	AM	52
Cynometra sanagaensis	AM	445
Cytisus scoparius	AM	260, 261
Dalbergia obtusifolia	AM	655
Dalbergia sissoo	AM	317, 473
Daniella ogea	AM	445
Daviesia corymbosa	AM	67
Desmanthus illinoensis	AM	541
Desmodium heterophyllum	AM	355
Desmodium microphyllum	AM	343
Desmodium oxyphyllum	AM	643
Desmodium paniculatum	AM	541
Detarium macrocarpum	AM	445
Dialium guineense	AM	47, 52
Dicorynia guianensis	AM	71, 161
Didelotia africana	ECM + Weak AM	413
	ECM	445
Didelotia letouzeyi	ECM	413, 445
Dillwyinia parvifolia var. tricopoda	ECM+AM	67
Dillwynia retorta	ECM	67
	AM	589
Diphysa robinoides	AM	143
Dipteryx panamensis	AM	321

Examined species[a]	Mycorrhizal status[b,c]	References
Distemonanthus benthamianus	AM	445
Dorycnium hirsutum	NM	368
Enterolobium contortisiliquum	AM	211, 651
Enterolobium cyclocarpum	AM	143, 256
Eperua falcata	AM	161
Erythrina berteroana	AM	142
Erythrina crista-galli	AM	211
Erythrina poeppigiana	AM	148
Erythrophleum ivorense	AM	52, 445
Eysenhardtia polystachya	Weak AM	103
Faidherbia albida	AM	46
Genista hirsute	AM	339
Genista tinctoria	AM	260, 261
Geoffroea decorticians	AM	211
Gilbertiodendron brachystegioides	ECM	445
Gilbertiodendron dewevrei	ECM+AM	591
	ECM	445
Gilbertiodendron preussi	ECM	52
Gleditsia amorphoides	Weak AM + ECM	211
Gliricidia sepium	AM	52, 199, 258
Glyceria maxima	NM	62
Glycine max	AM	37
Gompholobium grandiflorum	AM	67
Gossweilerodendron balsamiferum	AM	445
Guibourtia tessmannii	AM	445
Havardia albicans	AM	18
Hedysarum confertum	AM	496
Hedysarum coronarium	AM	351
Hedysarum spinosissimum	AM	496
Hippocrepis comosa	AM	260, 261
Hippocrepis unisiliquosa	AM	472
Holocalyx balansae	Weak AM	651
Hymenaea courbaril	NM	548
Indigofera brevidens	Weak AM	438
Indigofera cordifolia	AM	567
Indigofera linifolia	AM	567
Inga leiocalycina	AM	627
Inga marginata	AM	31
Inga sessilis	AM	651
Inga striata	AM	651
Inga urguuensis	AM	211
Intsia palembanica	AM + ECM	14
Julbernardia seretii	ECM+AM	591
	ECM	445
Koompassia malacensis	NM	568
Kummerowia striata	AM	213
Lablab purpureusus	AM	640
Laburnum anagyroides	AM	260, 261

Examined species[a]	Mycorrhizal status[b,c]	References
Lathyrus montanus	AM	260, 261
Lathyrus japonicus	AM	260, 261
Lathyrus niger	AM + NM	260, 261
Lathyus odoratus	AM	260, 261
Lathyrus pratensis	AM	194
	AM + NM	260, 261
Lens culinaris	AM	319
Leucaena leucocephala	AM	18, 52, 254, 326
Lonchocarpus campestris	AM	651
Lonchocarpus muehlbergianus	Weak AM	651
Lonchocarpus nitidus	AM + ECM	211
Lotus corniculatus	AM	140, 159, 194, 307, 456
	AM + NM	260, 261
Lotus glaber	AM	508
Lotus tenuis	AM	396
Lotus uliginosus	AM	260, 261
Lupinus arcticus	NM	594
Lysiloma candida	AM	112
Machaerium minutiflorum	AM	651
Machaerium stipitatum	Weak AM	651
Macrotyloma uniflorum	AM	453
Medicago littoralis	AM	368
Medicago lupulina	AM	260, 261
Medicago marina	AM	368
Medicago polymorpha	AM	294, 260, 261
Medicago sativa	AM	38, 159, 351, 260, 261
Melilotus alba	AM	260, 261
Melilotus officinalis	AM	159, 260, 261
Microberlinia bisulcata	ECM	413
Mimosa adenantheroides	Weak AM	103
Mimosa bimucronata	AM	452
Mimosa biuncifera	Weak AM	103
	AM	82
Mimosa calcicola	Weak AM	103
Mimosa lacerata	Weak AM	103
Mimosa luisana	AM	103
Mimosa polyantha	Weak AM	103
Mimosa pudic	AM	326
Mimosa purpusii	Weak AM	103
Mimosa scabrella	AM	31, 651
Mimosa texana	Weak AM	103
Monopetalanthus le-testui	ECM	445
Monopetalanthus microphyllus	ECM	445
Mora excelsa	AM	592
Olneya tesota	AM	112
Onobrychis viciifolia	AM	260, 261
Onobrychis sativa	AM	260, 261
Ononis repens	AM	260, 261
Ononis spinosa	AM	260, 261
Ormosia arborea	NM	548
	AM	651
Oxystigma buchholzii	AM	445
Oxystigma mannii	AM	445
Oxytropis scammaniana	AM	594
Pachyelasma tessmannii	AM	445
Paraberlinia bifoliolata	ECM	445
Parapiptadenia rigida	AM	211, 452, 651
Parkia bicolor	AM	52
Parkia biglobosa	AM	47, 247
Parkia speciosa	AM	14
Parkinsonia aculeata	AM	211
Peltophorum dubium	AM	211
	NM	548, 651
Pentaclethra macrophyll	AM	52, 445
Phaseolus lunatus	AM	20
Phaseolus mungo	AM	478
Phaseolus radiatus	AM	478
Phaseolus vulgaris	AM	37
Piptadeniastrum africanum	AM	52, 445
Plagiosiphon longitubus	AM	445
Plagiosiphon multijugus	AM	445
Platycyamus regnellii	AM	548
Poecilanthe parviflora	AM	211, 651
Prioria copaifera	AM	592
Prosopis articulata	AM	112
Prosopis cineraria	AM	379
Prosopis glandulose	AM	137
Prosopis juliflora	AM	76, 175, 567
Prosopis laevigata	AM	495
Psoralea bituminosa	AM	472
Pterocarpus angolensis	AM	419
Pterocarpus mildbraedii	AM	445
Pterocarpus soyauxii	AM	445
Pterogyne nitens	Weak AM	651
Pueraria phaseoloides	AM	150
Pultenaea elliptica	ECM + AM	67
Retama sphaerocarpa	AM	16, 17, 497
Robinia pseudoacacia	ECM	330
	AM + ECM	582, 260, 261
	ECM + EEM	86
Samanea saman	AM	52
Schizolobium parahyba	AM	548
Schrankia quadrivalvis	AM	143
Scorodophloeus zenkeri	AM	445
Scorpiurus muricatus	AM	472
Senna corymbosa	AM	211
Senna macranthera	AM	548, 651
Senna multijuga	AM	548
Senna siamea	AM	441
Senna spectabilis	AM	548
Sesbania aegyptiaca	AM	231

Examined species[a]	Mycorrhizal status[b,c]	References
Sesbania grandiflora	AM	231
Sesbania punicea	AM	211
Sesbania tomentosa	AM	326, 227
Sophora chrysophylla	AM	326, 406
Spartium junceum	AM	368
Strophostyles helvola	AM	596
Strophostyles umbellata	AM	532
Stryphnodendron microstachyum	AM	36
Stylosanthes guvanensis	AM	545
Stylosanthes scarbaeoidesand	AM	545
Swainsona phacoides	AM	438
Tamarindus indica	AM	47, 247, 343
Tephrosia purpurea	AM	216, 343
Tephrosia sphaerospora	AM	438
Tetraberlinia bifoliolata	ECM + Weak AM	413
	ECM	445
Tetraberlinia moreliana	ECM	413
Tipuana tipu	AM	548
Toubaouate brevipaniculata	ECM	445
Trifolium arvense	AM	307
Trifolium aureum	AM	194
Trifolium dubium	AM	643, 260, 261
Trifolium fragiferum	NM	260, 261
Trifolium glomeratum	AM	260, 261
Trifolium hybridum	AM	307
	AM + NM	260, 261
Trifolium medium	AM	260, 261
Trifolium pratense	AM	140, 159, 194, 204, 456
	AM + NM	260, 261
Trifolium repens	AM	140, 194, 283, 643, 260, 261
Trifolium spadiceum	AM	194
Trifolium subterraneum	AM	171
	AM + NM	260, 261
Trigonella foenumgraecum	AM	220
Ulex europaeus	AM	368, 260, 261
Ulex gallii	NM	260, 261
Ulex parviflorus	AM	497
Vicia angustifolia var. segetalis	AM	643
Vicia cracca	AM	194, 294, 260, 261
Vicia faba	AM	191
Vicia nigricans	AM	207
Vicia hirsute	AM	643, 260, 261
Vicia sativa	AM	260, 261
Vicia sepium	AM	194, 260, 261
Vicia sylvatica	AM + ECM	260, 261
Vicia tetrasperma	AM	307, 260, 261
Vicia villosa	AM	140
Vigna aconitifolius	AM	343
Vigna luteola	AM	273
Vigna marina	AM	326, 547
Vigna mungo	AM	319
Vigna parkeri	AM	440
Vigna radiate	AM	377
Vigna unguiculata	AM	37, 287
Xylia xylocarpa	AM	315
Zornia sp.	Weak AM	103
Rosaceae		
Acaena magellanica	AM	342
Acaena minor	NM	560
	AM	342
Acaena novae-zelandiae	AM	260, 261
Acaena ovalifolia	AM	207
Acaena pinnatifida	AM	207
Adenostoma fasciculatum	AM + ECM	21
Agrimonia eupatoria	AM	260, 261
Alchemilla alpina	AM	80, 194, 260, 261
Alchemilla glabra	AM	260, 261
Alchemilla glaucescens	AM	194
Alchemilla glomerulans	AM	503
Alchemilla vulagris agg.	AM + NM	260, 261
Alchemilla xanthochlora	AM	260, 261
Aphanes arvensis	AM	260, 261
Cotoneaster integerrimus	AM	260, 261
Crataegus laevigata	AM + ECM	260, 261
Crataegus monogyna	ECM	368
	AM + ECM	260, 261
Dryas octopetala	ECM	80, 594
	AM + ECM	260, 261
Duchesnea chrysantha	AM	643
Filipendula ulmaria	AM + NM	260, 261
Fragaria chiloensis	AM	207
Fragaria vesca	AM + NM	260, 261
Fragaria xananassa	AM	537
Geum rivale	AM	194
	AM + NM	260, 261
Geum urbanum	AM	260, 261
Geum virginianum	AM	140
Hagenia abyssinica	AM	637, 638
Malus communis	AM	260, 261
Malus domestica	AM	368
Malus micromalus	AM	26
Malus pumila var. domestica	AM	233
Malus sylvestris	AM + ECM	260, 261
Osteomeles anthyllidifolia	AM	326
Ovidia andina	AM	207
Potentilla anglica	AM	260, 261

Examined species[a]	Mycorrhizal status[b,c]	References
Potentilla anserine	AM	307, 626, 260, 261
Potentilla argentea	AM	260, 261
Potentilla cinerea	AM	456
Potentilla crantzii	AM	194, 260, 261
Potentilla erecta	AM	194, 586
	AM + NM	260, 261
Potentilla fruticosa	AM	260, 261
Potentilla hookeriana	AM	443
Potentilla palustris	AM + NM	260, 261
Potentilla pulchella	AM	443
Potentilla reptans	AM	260, 261
Potentilla sterilis	AM	260, 261
Potentilla tabernaemontani	AM	260, 261
Prunus africana	AM	637, 638
Prunus avium	AM	465
	AM + ECM	260, 261
Prunus cerasifera	AM	73
Prunus cerasus	ECM	260, 261
Prunus domestica	AM + NM	260, 261
Prunus maritima	AM	324
Prunus padus	AM + ECM	260, 261
Prunus sellowii	Weak AM	651
Prunus spinosa	AM + NM	260, 261
Pyrus communis	AM	219
Pyrus pyraster	AM + ECM	260, 261
Rosa arvensis	AM	260, 261
Rosa canina	AM	81, 260, 261
Rosa hybrida	AM	160
Rosa rubiginosa	AM	207
Rosa rugosa	AM	324
Rosa sempervirens	AM	368
Rubus caesius	AM	260, 261
Rubus chamaemorus	NM	260, 261
Rubus fruticosus s. l.	AM	260, 261
Rubus idaeus	AM	573, 574
	AM + NM	260, 261
Rubus nessensis	AM + ECM	260, 261
Rubus rufus	AM	422
Rubus saxatilis	AM	260, 261
Rubus ulmifolius	AM	368
Sanguisorba minor	AM	260, 261
Sanguisorba officinalis	AM	260, 261
Sibbaldia procumbens	AM	594
	NM	260, 261
Sorbus aria	AM + ECM	260, 261
Sorbus aucuparia	AM + ECM + NM	260, 261
Sorbus torminalis	ECM	260, 261
Spiraea latifolia	AM	140
Spiraea tomentosa	AM	140
Rhamnaceae		
Colletia hystrix	AM	207
Colubrina glabra	AM	112
Colubrina glandulosa	AM	651
Colubrina oppositifolia	AM	227
Condalia globosa	AM	112
Discaria articulata	AM	207
Discaria chacaye	AM	207
Frangula alnus	AM + ECM + NM	260, 261
Hovenia dulcis	AM	548
Phylica ericoides	AM	24
Rhamnus catharticus	AM + NM	260, 261
Rhamnus lycioides	AM	17, 108
Ventilago calyculata	AM	655
Zizyphus mauritiana	AM	47, 343, 378, 381, 655
Zizyphus nummularia	AM	567
Zizyphus obtusifolia	AM	112
Ziziphus xylopyrus	AM	380
Elaeagnaceae		
Elaeagnus commutata	AM	613
Hippophae rhamnoides	AM	405, 260, 261
Hippophae tibetana	AM	581
Shepherdia canadensis	AM	581
Ulmaceae		
Celtis wightii	AM	422
Gironniera subaequalis	NM	422
Trema micrantha	AM	548, 651
Trema orientalis	AM	445
Ulmus glabra	AM	260, 261
Ulmus procera	AM + ECM	260, 261
Cannabaceae		
Humulus lupulus	AM + NM	260, 261
Moraceae		
Artocarpus altilis	AM	136
Brosimum alicastrum	AM	18
Brosimum lactescens	AM	31
Broussonetia papyrifera	AM	343
Ficus cyrtophylla	NM	655
Ficus guaranitica	AM	651
Ficus hirta	AM	422
Ficus hispida	AM	655
Ficus langkokensis	AM	655
Milicia excelsa	AM	445
Milicia regia	AM	279
Morus alba	AM	475, 535
Musanga cecropioides	AM	445
Sorocea bonplandii	Weak AM	651
Urticaceae		
Boehmeria zollingeriana	AM	422
Cecropia glaziovii	AM	651
Cecropia pachystachya	AM	651
Elatostema parvum	AM	422
Parietaria judaica	AM + NM	260, 261
Pipturus albidus	AM	326

Examined species[a]	Mycorrhizal status[b,c]	References
Touchardia latifolia	NM	326
Urera glabra	AM	326
Urtica dioica	NM	611
	AM + NM	260, 261
Urtica urens	NM	260, 261
Cucurbitaceae		
Bryonia dioica	AM	260, 261
Citrullus lanatus	AM	310, 438
Ctenolepis cerasiformis	AM	567
Cucumis callosus	AM	567
Cucumis sativus	AM	499
Cucurbita foetidissima	AM	396
Cucurbita pepo	AM	340
Mukia maderaspatana	AM	216
Begoniaceae		
Begonia angustinei	AM	422
Begonia cathayana	AM	422
Hillebrandia sandwicensis	AM	326
Tetramelaceae		
Tetrameles nudiflora	AM	422
Fagaceae		
Castanea sativa	ECM	260, 261
Castanopsis borneensis	ECM	267
Castanopsis indica	NM	422
	AM	655
Fagus sylvatica	ECM	529, 260, 261
Lithocarpus densiflora	ECM	375
Lithocarpus leucostachyus	NM	422
Nothofagus dombeyi	ECM	207
Quercus alba	ECM	444, 470
Quercus cerris	ECM	260, 261
Quercus ilex	ECM	368, 472, 260, 261
Quercus petraea	ECM	53, 260, 261
Quercus pubescens	ECM	138
Quercus robur	ECM	53, 368, 260, 261
Quercus rubra	ECM	214
Myricaceae		
Comptonia peregrina	Facultative AM	284
Myrica cerifera	AM	468
Myrica faya	AM	326
Myrica gale	Facultative AM	146
	AM + NM	260, 261
Myrica pensylvanica	NM	324
	Facultative AM	284
Juglandaceae		
Engelhardtia roxburghiana	ECM	267
Juglans nigra	AM	465
Juglans regia	AM	177
	AM + ECM + NM	260, 261
Betulaceae		
Alnus acuminata	ECM	61
Alnus cordata	AM	361
Alnus glutinosa	AM	210
	ECM + AM	368
	ECM	471
	AM + ECM + EEM + NM	260, 261
Alnus incana	AM	34
	AM + ECM	260, 261
Alnus sinuate	ECM	271
Alnus tenuifolia	ECM	641
Betula alleghaniensis	ECM	162, 516
Betula lenta	ECM	619
Betula nana	ECM	594, 260, 261
Betula papyrifera	ECM	303
Betula pendula	ECM	92, 155
	ECM+EEM	260, 261
Betula pubescens	ECM	370
	ECM+EEM	260, 261
Betula verrucosa	ECM	217
Carpinus betulus	ECM	529, 260, 261
Corylus avellana	ECM	367, 529, 260, 261
Casuarinaceae		
Allocasuarina littoralis	ECM	579
Casuarina cunninghamiana	Weak AM	485
	AM	316
	Weak ECM	579
Casuarina equisetifolia	AM	447, 326, 542, 606
Casuarina equisetifolia ssp. equisetifolia	ECM	579
Tropaeolaceae		
Tropaeolum majus	AM	360, 610
Moringaceae		
Moringa concanensis	AM	450
Caricaceae		
Carica papaya	AM	360, 595
Bataceae		
Batis maritime	NM	326
Resedaceae		
Reseda lutea	AM + NM	260, 261
Reseda luteola	AM + NM	260, 261
Capparidaceae		
Atamisquea emarginata	AM	112
Capparis sandwichiana	NM	326
Brassicaceae		
Alliaria petiolata	NM	260, 261
Alyssum montanum	NM	456
Arabidopsis thaliana	Weak AM + NM	260, 261
Arabis alpina	NM	260, 261
Arabis hirsuta	NM	472, 260, 261

Examined species[a]	Mycorrhizal status[b,c]	References
Armoracia rusticana	AM + NM	260, 261
Barbarea vulgaris	NM	260, 261
Biscutella laevigata	NM	456
	AM	446, 260, 261
Blennodia pterosperma	NM	438
Brassica napus	AM + NM	260, 261
Brassica nigra	NM	83, 260, 261
Brassica oleracea	AM + NM	260, 261
Brassica rapa	NM	260, 261
Cakile maritima	NM	368
	AM + NM	260, 261
Capsella bursa-pastoris	Facultative AM	167
	AM	164
	AM + NM	260, 261
Cardamine amara	NM	260, 261
Cardamine bulbifera	AM + NM	260, 261
Cardamine concatenata	NM	165
Cardamine corymbosa	NM	342
Cardamine flexuosa	AM + NM	260, 261
Cardamine hirsuta	AM + NM	260, 261
Cardamine impatiens	NM	260, 261
Cardamine pratensis	NM	260, 261
Cardamine trifolia	NM	260, 261
Cardaminopsis arenosa	AM	456
Cochlearia anglica	AM + NM	260, 261
Cochlearia danica	AM	260, 261
Cochlearia officinalis	AM + NM	260, 261
Diplotaxis erucoides	AM + NM	260, 261
Diplotaxis muralis	AM + NM	260, 261
Erophila verna	NM	260, 261
Erysimum cheiranthoides	NM	260, 261
Hesperis matronalis	Facultative AM	167
Iberis amara	AM	260, 261
Isatis tinctoria	NM	260, 261
Lepidium bidentatum	AM	326
Lepidium phlebopetalum	NM	438
Lepidium ruderale	NM	260, 261
Lepidium serra	NM	326
Matthiola incana	Facultative AM	167
Nasturtium officinale	NM	260, 261
Pringlea antiscorbutica	NM	560
Raphanus raphanistrum	NM	260, 261
Raphanus sativus	AM + NM	260, 261
Rorippa amphibia	NM	62
Rorippa islandica	AM	140
Rorippa palustris	NM	260, 261
Sinapis alba	NM	260, 261
Sisymbrium loeselii	NM	260, 261
Sisymbrium officinale	AM + NM	260, 261
Sisymbrium orientale	NM	260, 261
Thlaspi arvense	NM	260, 261
Thlaspi caerulescens	AM	488
Thlaspi montanum	AM	488
Thlaspi praecox	AM	488, 614
Thymelaeaceae		
Daphne laureola	AM	260, 261
Daphne gnidium	AM	368
Daphne mezereum	AM + NM	260, 261
Gonystylus bancanus	AM	568
Pimelea linifolia	AM	67
Wikstroemia furcata	AM	326
Bixaceae		
Cochlospermum vitifolium	AM	20
Cistaceae		
Cistus creticus	ECM	368
Cistus ladanifer	ECM	339
Cistus incanus	ECM	368
Cistus monspeliensis	ECM	368
	ECM + AM	472
Fumana thymifolia	AM	472
Helianthemum almeriense	EEM + ECM	249
Helianthemum apenninum	AM + ECM + EEM	260, 261
Helianthemum canum	AM + ECM + EEM	260, 261
Helianthemum guttatum	ECM + EEM	209
Helianthemum	ECM	80
nummularium	AM + ECM + EEM	260, 261
Helianthemum ovatum	ECM	330
Tuberaria guttata	ECM	260, 261
Dipterocarpaceae		
Hopea mengarawan	NM	568
Shorea balangeran	AM	568
Shorea leprosula	ECM	14
Shorea teysmanniana	AM	568
Shorea uliginosa	AM	568
Malvaceae		
Abelmoschus esculentus	AM	69
Abutilon californicum	AM	112
Abutilon indicum	AM	343
Abutilon otocarpum	AM	438
Abutilon theophrasti	AM	553
Althaea officinalis	AM	260, 261
Bastardiopsis densiflora	AM	651
Gossypium hirsutum	AM	7, 649
Gossypium tomentosum	AM	326
Kokia kauaiensis	AM	326
Malva sylvestris	AM	260, 261

Examined species[a]	Mycorrhizal status[b,c]	References
Thespesia populnea	AM	326
Sida ammophila	NM + Weak AM	438
Sida cordifolia	AM	567
Sida fallax	AM	326
Sida szechuensis	AM	343
Malvaceae (Bombacoideae)		
Adansonia digitata	AM	47
Bombax malabaricum	AM	343
Ceiba pentandra	AM	18
Ceiba speciosa	AM	548
Chorisia speciosa	AM	651
Ochroma pyramidale	AM	321
Pseudobombax grandiflorum	AM	651
Malvaceae (Tilioideae)		
Corchorus tridens	AM	567
Grewia biloba	AM	343
Heliocarpus americanus	AM	651
Heliocarpus appendiculatus	AM	244, 245
Heliocarpus pallidus	AM	20
Luehea candicans	AM	651
Luehea divaricata	AM	651
Luehea grandiflora	AM	548
Luehea seemannii	AM	321
Tilia cordata	ECM	529
	AM + ECM + NM	260, 261
Tilia platyphyllos	ECM	549, 260, 261
Tilia × vulgaris	ECM	260, 261
Malvaceae (Sterculioideae)		
Eribroma oblonga	AM	445
Guazuma ulmifolia	AM	18, 32, 651
Pterigota macrocarpa	AM	445
Pterospermum menglunense	AM	422
Pterospermum yunnanensis	AM	655
Theobroma cacao	AM	131, 321
Waltheria indica	AM	143, 326
Rutaceae		
Acronychia pedunculata	AM	655
Agathosma ovata	AM	24
Boronia thujona	AM	67
Citrus aurantifolia	AM	400
Citrus aurantium	AM	429
Citrus jambhiri	AM	176
Eriostemon australasius	AM	67
Fagara heitzii	AM	445
Flindersia brayleana	AM	222
Melicope barbigera	AM	326
Paramignya retispina	AM	655
Zanthoxylum rhetsa	AM	315
Meliaceae		
Azadirachta excelsa	AM	282
Azadirachta indica	AM	255, 427, 477
Cabralea canjerana	AM	31
Cedrella fissilis	AM	548, 593, 651
Chisocheton siamensis	Facultative AM	422
Ekebergia capensis	AM	637, 638
Entandrophragma angolense	AM	445
Entandrophragma candollei	AM	445
Entandrophragma cylindricum	AM	445
Entandrophragma utile	AM	445
Guarea cedrata	AM	445
Guarea kunthiana	Weak AM	651
Khaya ivorensis	AM	445
Lansium domesticum	AM	422
Lovoa trichilioides	AM	445
Melia azedarach	AM	422
Melia toosanden	NM	422
Swietenia macrophylla	AM	433
Trichilia casaretti	Weak AM	651
Trichilia claussenii	Weak AM	651
Trichilia elegans	Weak AM	651
Simaroubaceae		
Castella peninsularis	AM	112
Irvingia gabonensis	AM	445
Anacardiaceae		
Anacardium excelsum	AM	321
Anacardium occidentale	AM	27, 47
Antrocaryon klaineanum	AM	445
Astronium graveolens	AM	651
Campnosperma auriculatum	AM	568
Cyrtocarpa edulis	AM	112
Mangifera sp.	AM	486
Pistacia atlantica	AM	197
Pistacia lentiscus	AM	368, 472
Pistacia palestina	AM	197
Pistacia terebinthus	AM	104
Pistacia vera	AM	197
Schinus patagonicus	AM	207
Schinus terebinthifolius	AM	548, 651
Sclerocarya birrea	AM	47
Trychoscypha acuminata	AM	445
Burseraceae		
Bursera fagaroides	NM	103
	AM	112
Bursera hindsiana	Weak AM	112
Bursera microphylla	Weak AM	112
Canarium schweinfurthii	AM	445
Sapindaceae		
Acer campestre	AM + ECM + NM	260, 261

Examined species[a]	Mycorrhizal status[b,c]	References
Acer platanoides	AM	607
	AM + ECM + NM	260, 261
Acer pseudoplatanus	AM	465, 622
	AM + ECM + NM	260, 261
Acer rubrum	AM	140
Acer saccharum	AM	141, 162, 470
Aesculus hippocastanum	AM	260, 261
Allophylus schweinfurthii	AM	445
Aphania senegalensis	AM	47
Blighia welwitschii	AM	445
Cardiospermum corindum	AM	112
Deinbollia pycnophylla	AM	445
Dodonaea viscosa	AM	326, 343, 479
Eriocoelum macrocarpum	AM	445
Harpullia cupanioides	AM	655
Lepisanthes senegalensis	Facultative AM	422
Litchi chinensis	AM	326
Matayba guianensis	AM	31
Pometia tomentosa	AM	422
	NM	655
Sapindus saponaria	AM	548
Some unplaced taxa		
Bruniaceae		
Staavia radiata	AM	24
Escalloniaceae		
Escallonia rubra	AM	207

[a]The families in column 1 are divided into four groups: bryophytes, pteridophytes, gymnosperms and angiosperms. For each group, the order off amilies is consistent with the phylogeny used in Fig. 1.

[b]The mycorrhizal types shown in column 2 are consistent to the current widely used system of Smith and Read (1997): AM arbuscular mycorrhiza, ECM ectomycorrhiza, EEM ectendomycorrhiza, ORM orchid mycorrhiza, ERM ericoid mycorrhiza, MTM monotropoid mycorrhiza, ABM arbutoid mycorrhiza, as well as NM nonmycorrhiza, and mycoheterotrophy

[c]For the bryophytes, fungal associations were used instead of mycorrhiza; A, B, and G indicate ascomycetous, basidiomycetous, and glomeromycetous fungal associations, respectively

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Appendix B

Commercial mycorrhizal inocula available 2011

Product	Fungal Species	Group	%	Origin	Source 2011-Jan
AgBio-Ectos	Pisolithus tinctorius Rhizopogon amylopogon Rhizopogon fulvigleba Rhizopogon luteolus Rhizopogon villosullus	EMF EMF EMF EMF EMF	no data no data no data no data no data	no data no data no data no data no data	AgBio Inc 9915 Raleigh St Westminister CO 80030 USA 877-268-2020 http://www.agbio-inc.com
AgBio-Endos	unspecified mix of arbuscular mycorrhiza	AMF	no data	no data	AgBio Inc 9915 Raleigh St Westminister CO 80030 USA 877-268-2020 http://www.agbio-inc.com
AM120 Basin & High Plains Suite	Glomus etunicatum Glomus intraradices Glomus intraradices	AMF AMF AMF	25% 25% 50%	NE AZ UT	Reforestation Technologies International 341 Dayton Street, Unit G Salinas CA 93901 USA 800-784-4769 http://www.reforest.com
AM120 California Coastal Suite	Glomus caledonium Glomus intraradices Glomus mosseae	AMF AMF AMF	25% 50% 25%	CA UT CA	Reforestation Technologies International 341 Dayton Street, Unit G Salinas CA 93901 USA 800-784-4769 http://www.reforest.com
AM120 Desert Suite	Glomus deserticola Glomus intraradices Glomus intraradices	AMF AMF AMF	25% 25% 50%	CA AZ UT	Reforestation Technologies International 341 Dayton Street, Unit G Salinas CA 93901 USA 800-784-4769 http://www.reforest.com
AM120 Standard	Glomus intraradices	AMF	100%	UT	Reforestation Technologies International 341 Dayton Street, Unit G Salinas CA 93901 USA 800-784-4769 http://www.reforest.com
BioVam	unspecified mix of ectomycorrhiza and arbuscular mycorrhiza, plus soil bacteria	EMF AMF	no data	no data	Brock Probiotics 1224 Calle Tulipan Thousand Oaks CA 91360 USA 805-496-0722 http://www.tandjenterprises.com
BuRIZE	Glomus intraradices	AMF	100%	no data	BioScientific, Inc 4405 S. Litchfield Rd Avondale AZ 85323 USA 800-872-2461 http://www.biosci.com

Product	Fungal Species	Group	%	Origin	Source 2011-Jan
DIEHARD	Glomus deserticola	AMF	no data	no data	Horticultural Alliance, Inc. 1550 66th Ave Drive East Sarasota FL 34243 USA 800-628-6373 http://www.horticulturalalliance.com
	Glomus dussii	AMF	no data	no data	
	Glomus fasciculatum	AMF	no data	no data	
	Glomus intraradices	AMF	no data	no data	
	Glomus microaggregatum	AMF	no data	no data	
	Glomus mosseae	AMF	no data	no data	
ECOVAM	Glomus deserticola	AMF	no data	no data	Horticultural Alliance, Inc. 1550 66th Ave Drive East Sarasota FL 34243 USA 800-628-6373 http://www.horticulturalalliance.com
	Glomus dussii	AMF	no data	no data	
	Glomus fasciculatum	AMF	no data	no data	
	Glomus intraradices	AMF	no data	no data	
	Glomus microaggregatum	AMF	no data	no data	
	Glomus mosseae	AMF	no data	no data	
Endomycorrhizae Powder	Glomus aggregatum	AMF	25%	no data	Mycorrhizal Symbiotics Portland OR 97212 USA 541-430-3694 http://mycorrhizalsymbiotics.com
	Glomus intraradices	AMF	25%	no data	
	Glomus etunicatum	AMF	25%	no data	
	Glomus mosseae	AMF	25%	no data	
Endomycorrhizal Inoculant (BEI)	Glomus aggregatum	AMF	no data	no data	BioOrganics, Inc PO Box 5326 Palm Springs CA 92263 USA 888-332-7676 http://www.bio-organics.com
	Glomus clarum	AMF	no data	no data	
	Glomus deserticola	AMF	no data	no data	
	Glomus intraradices	AMF	no data	no data	
	Glomus monosporus	AMF	no data	no data	
	Glomus mosseae	AMF	no data	no data	
	Paraglomus brasilianum	AMF	no data	no data	
Great White	unspecified mix of 15 ectomycorrhiza and arbuscular mycorrhiza, plus 19 species of soil bacteria	EMF AMF	no data	no data	Plant Revolution, Inc. 2133 S Hathaway St Santa Ana, CA 92705 USA 714-545-5335 http://www.plant-success.com
GroLife	Gigaspora margarita	AMF	no data	no data	GroPower 15065 Telephone Ave Chino CA 91710-9614 USA 909-393-3744 http://gropower.com
	Glomus aggregatum	AMF	no data	no data	
	Glomus intraradices	AMF	no data	no data	
	Glomus mosseae	AMF	no data	no data	
	Pisolithus tinctorius	EMF	no data	no data	
	Rhizopogon amylopogon	EMF	no data	no data	
	Rhizopogon fulvigleba	EMF	no data	no data	
	Rhizopogon luteolus	EMF	no data	no data	
	Rhizopogon villosullus	EMF	no data	no data	

Product	Fungal Species	Group	%	Origin	Source 2011-Jan
MycoApplyEndo	unspecified mix of 4 arbuscular mycorrhiza	AMF	no data	no data	Mycorrhizal Applications, Inc 810 NW E St Grants Pass OR 97526 USA 866-476-7800 http://www.mycorrhizae.com
MycoApply Soluble MAXX	unspecified mix of 9 ectomycorrhiza and 11 arbuscular mycorrhiza	EMF AMF	no data	no data	Mycorrhizal Applications, Inc 810 NW E St Grants Pass OR 97526 USA 866-476-7800 http://www.mycorrhizae.com
MycorisePro	Glomus intraradices	AMF	100%	no data	PremierTech 127 South Fifth Street, #300 Quakertown PA 18951 USA 800 525-2553 http://www.premierhort.com
MycoRoot Green	unspecified mix of arbuscular mycorrhiza	AMF	no data	Southern African non-GMO	MycoRoot PO Box 7026 Grahamstown North 6148 South Africa +27 83 636 0706 http://www.mycoroot.com
MycoRoot SuperBooster	unspecified mix of arbuscular mycorrhiza	AMF	no data	Southern African non-GMO	MycoRoot PO Box 7026 Grahamstown North 6148 South Africa +27 83 636 0706 http://www.mycoroot.com
MycoRoot SuperGro	unspecified mix of arbuscular mycorrhiza	AMF	no data	Southern African non-GMO	MycoRoot PO Box 7026 Grahamstown North 6148 South Africa +27 83 636 0706 http://www.mycoroot.com
MycoRoot Supreme	unspecified mix of arbuscular mycorrhiza	AMF	no data	Southern African non-GMO	MycoRoot PO Box 7026 Grahamstown North 6148 South Africa +27 83 636 0706 http://www.mycoroot.com
Mycorrhizal Landscape Inoculant (LA)	Laccaria laccata Pisolithus tinctorius Rhizopogon amylopogon Rhizopogon fulvigleba Rhizopogon rubescens Rhizopogon villosullus Scleroderma cepa Scleroderma citrinum	EMF EMF EMF EMF EMF EMF EMF EMF	no data no data no data no data no data no data no data no data	no data no data no data no data no data no data no data no data	BioOrganics, Inc PO Box 5326 Palm Springs CA 92263 USA 888-332-7676 http://www.bio-organics.com

Appendix B. Commercial Mycorrhizal Inocula Available 2011

Product	Fungal Species	Group	%	Origin	Source 2011-Jan
MYCOSYM TRI-TON	Glomus intraradices	AMF	100%	no data	MYCOSYM International AG Centralbahnstrasse 9 BASEL CH-4051 Switzerland +41 61 271 8614 http://www.mycosym.com
Plant Success	unspecified mix of 13 ectomycorrhizae and arbuscular mycorrhizae	EMF AMF	no data	no data	Plant Revolution, Inc. 2133 S Hathaway St Santa Ana, CA 92705 USA 714-545-5335 http://www.plant-success.com
Rhizofuel	unspecified mix of 7 ectomycorrhiza and 4 arbuscular mycorrhiza, plus soil bacteria	EMF AMF	no data	no data	Rootgrow, Inc. 135 Allen Blvd, Suite 1 Farmingdale, NY 11735 1-866-766-8476 http://rhizofuel.com
RUTOPIA+M	Gigaspora margarita	AMF	no data	no data	NaEx Corp-Poulenger USA, Inc. 10202 BLDG E Mula Circle Stafford TX 77477 USA 800-956-0063 http://www.poulengerusa.com
	Glomus clarum	AMF	no data	no data	
	Glomus deserticola	AMF	no data	no data	
	Glomus etunicatum	AMF	no data	no data	
	Glomus intraradices	AMF	no data	no data	
	Glomus mosseae	AMF	no data	no data	
	Paraglomus brasilianum	AMF	no data	no data	
	Pisolithus tinctorius	EMF	no data	no data	
SOLRIZE	Glomus intraradices	AMF	100%	no data	Biorize SARL Rue Sainte Anne 8 Dijon 21000 France http://www.biorize.com
SYMBIVIT	Glomus claroideum	AMF	no data	no data	Symbiom Ltd. Lanskroun 563 01 Czech Republic http://www.symbiom.cz
	Glomus etunicatum	AMF	no data	no data	
	Glomus geosporum	AMF	no data	no data	
	Glomus intraradices	AMF	no data	no data	
	Glomus microaggregatum	AMF	no data	no data	
	Glomus monosporus	AMF	no data	no data	
	Glomus mosseae	AMF	no data	no data	
TerraPro	Gigaspora margarita	AMF	no data	no data	Soil Secrets, LLC 9 Gilcrease LN Los Lunas, NM 87031 505-866-7645 http://www.soilsecrets.com
	Glomus aggregatum	AMF	no data	no data	
	Glomus clarum	AMF	no data	no data	
	Glomus deserticola	AMF	no data	no data	
	Glomus intraradices	AMF	no data	no data	
	Glomus mosseae	AMF	no data	no data	
	Paraglomus brasilianum	AMF	no data	no data	
	Pisolithus tinctorius	EMF	no data	no data	
	Rhizopogon amylopogon	EMF	no data	no data	
	Rhizopogon fulvigleba	EMF	no data	no data	
	Rhizopogon luteolus	EMF	no data	no data	
	Rhizopogon villosullus	EMF	no data	no data	