MYKE® Pro

RESEARCH REPORT

From scientific researches to the professional markets:
NURSERY • GREENHOUSE • FIELD CROPS • FORESTRY • TURF
MYKE® PRO a unique line of 100% natural growth stimulants adapted specifically for consumers and professionals.

PRODUCTS
DESIGNED
SPECIFICALLY FOR
DIFFERENT USES

PREFACE

Sensitive to environmental protection and public health, Premier Tech Biotechnologies has developed a line of products containing mycorrhizal fungi, these beneficial microorganisms contribute to plant success by enhancing growth and resistance.

The objective of this research report is to present the various studies, conducted with collaborators on various plant species and performed with the mycorrhizal fungi found in professional products design for:

NURSERY • GREENHOUSE • FIELD CROPS • FORESTRY • TURF

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INTRODUCTION

MYCORRHIZAE

The term “Mycorrhiza” describes the mutualistic, symbiotic relationship between fungi and plant roots. The symbiosis begins when fungal soil-borne spores germinate and the emerging hyphae enter the root surface. The hyphae grow within the plant root and extend out into the surrounding soil or growth medium acting as an extension of the root system. This relationship greatly increases the absorptive surface area of the root system and with the help of the fungus, the plant is able to obtain more mineral nutrients from the soil or media. It also makes the plant less susceptible to soil-borne pathogens and to other environmental stresses such as drought and salinity. In return the plant provides carbohydrates and other nutrients to the fungus. The fungi utilize these carbohydrates to synthesize and excrete molecules like glomalin (glycoprotein). The release of glomalin in the soil environment results in better soil structure and higher organic content.

Mycorrhizal fungi are found naturally in undisturbed soils around the world. They form symbiotic relationships with almost all plants ranging from ornamentals, fruits, vegetables, trees and shrubs. Most plants have a strong dependency on mycorrhizal fungi for optimal growth.

TYPES OF MYCORRHIZAL FUNGI

There are two major groups of mycorrhizal fungi: ectomycorrhizal and endomycorrhizal fungi. Members of the former group develop almost exclusively on the exterior of root cells, whereas those of the latter not only colonize the exterior but also penetrate the plant cells where more direct metabolic exchanges can occur. Ectomycorrhizae are essentially found on trees and form visible structures whereas endomycorrhizal fungi colonize trees as well as shrubs and most herbaceous plants and do not form visible strutures.

ENDOMYCORRHIZAL FUNGI

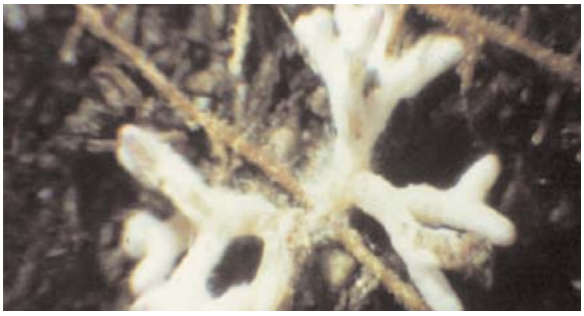
Among the types of endomycorrhizal fungi, arbuscular mycorrhizal (AM) fungi are the most prevalent in soils. Their name is derived from structures they form within the plant root: arbuscules. Arbuscules are finely-branched structures that form within a cell and serve as a major metabolic exchange site between the plant and the fungus. Vesicles are also found in some species of AM fungi, they are sac-like structures, emerging from hyphae, which serve as storage organs for lipids.

Other types of endomycorrhizal fungi do exist in nature but are specific to given families of plants Ex: orchids and the ericaceous families. The fungi involved in the mycorrhizal colonization of these plant families are currently not available in commercial products.

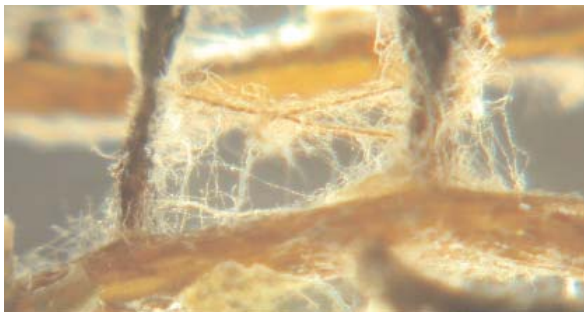
Roots colonized by an endomycorrhizal fungus. Hyphae extending into soil increase the surface area for nutrient absorption.

ECTOMYCORRHIZAL FUNGI

Ectomycorrhizal fungi are also found in natural environments, mainly in forests ecosystems. These fungi can form visible reproductive structures (mushrooms) at the feet of trees they colonize. Ectomycorrhizal fungi grow between root cells without penetrating them. Their hyphae grow externally, forming dense growth known as a fungal mantle. These fungi form symbiotic relationships with most pines, spruces and some hardwood trees including beech, birch, oak and willow.



Woolly felt on the characteristic Y shaped mycorrhizal roots of Pine colonized by an ectomycorrhizal fungus.



Pine tree roots heavily colonized by ectomycorrhizal hyphae. Emerging fruit bodies are frequently found on the soil surface.

WHY MYCORRHIZAE?

Fossil records show that mycorrhizal fungi have been around since the early beginnings of plant life on earth. However in most growth media and in most soils that have been disturbed by residential construction, heavy machinery or intensive cropping practices, the quantity of mycorrhizae has considerably diminished, and has become insufficient to significantly enhance plant growth. The addition of these organisms can thus improve plant growth and establishment.

One of the greatest benefits mycorrhizal fungi can generate for most plants is an increase in root absorption capacity. In fact, they have the capacity to bind nutrients that are often not available to the roots. Plants grown with mycorrhizae make better use of fertilizer and therefore are more resistant and healthier. Growth and flowering are enhanced in the presence of these beneficial organisms. Rooting is vigorous, survival is greater, especially in stressful environments. The establishment of newly seeded herbaceous plants such as turfgrass is improved. Examples of these benefits will be presented in the next sections according to the type of plant tested.

MAIN BENEFICIAL EFFECTS:

- Improves rooting, water absorption and nutrient availability
- Improves general plant health and resistance to various types of stress
- Reduces needs for fertilizers and pesticides
- Enhances resistance to diseases
- Sustains greater fruit and vegetable yields
- Increases growth and flower production
- Soil structure improvement

Since 1983, Premier Tech Biotechnologies has been conducting important researches and development studies in order to come up with leading edge technology in mycorrhizal fungi production. The use of the most sophisticated techniques and equipments allows Premier Tech Biotechnologies to manufacture mycorrhizal-based products of unrivalled quality and scale.

This innovative process is revolutionizing the horticultural and agronomical industry by bringing a solution to the loss of one of the most versatile and effective organisms: the mycorrhizal fungi. MYKE® PRO is the first line of 100% natural growth stimulants adapted to suit most plantations.

MYKE® Pro

NURSERY CROPS

Mycorrhizal fungi improve the quality and resistance of plants, resulting in reduced losses of container and field grown nursery crops.

MINIATURE ROSES TRIAL

INVESTIGATOR

Huiming Wang, Laval University, QC • 1991

OBJECTIVE

Evaluate the benefits of substrate inoculation with mycorrhizal fungi on recovery and growth of tissue cultured miniature roses.

METHODS

In vitro propagated plantlets of Rosa sp. "John Franklin" were transferred and acclimated in peat-based substrates under greenhouse conditions. Substrates were inoculated with *Glomus intraradices*, or non-inoculated. Vitro plants were grown in a small plastic tunnel with a mist for the first two weeks. After 2-4 weeks of gradual acclimatization, plantlets were placed in a greenhouse. Plants were watered as needed and fertilized weekly with a commercial solution weak in phosphorus (10 ppm).

Treatments were distributed using a randomized complete block design. There were a total of 30 plants per treatment: 10 plants in three different blocks. The survival in vitro plants was measured at 4 and 8 weeks after they were transferred in the peat-based substrates. Leaf dry weight was mea-sured by harvesting one random replicate of each treatment in each block after 4, 8, 11 and 17 weeks.

RESULTS

Mycorrhizal colonization began after 4 weeks of growth in the greenhouse but did not occur during the acclimatization period. Survival rates of inoculated plants were significantly higher than the controls by 10% (Table 1). Leaf dry weight was significantly higher than the controls for the mycorrhizal treatment (Table 2).

Table 1

Effects of mycorrhizal treatment on roses survival, 4 and 8 weeks after transplantation.

Treatment	% survival	
	4 weeks	8 weeks
with MYCORRHIZAE	96.7 b	93.3 b
without MYCORRHIZAE	88.6 a	85.0 a

In each column, values with different letters are statistically different at P = 0.05

Table 2

Treated and non treated rose leaf dry weight.

Treatment	Leaf dry weight (g)	
	4 weeks	8 weeks
with MYCORRHIZAE	0.14 b	0.50 b
without MYCORRHIZAE	0.11 a	0.26 a
	11 weeks	17 weeks
with MYCORRHIZAE	1.44 b	5.10 b
without MYCORRHIZAE	1.01 a	4.32 a

In each column, values with different letters are statistically different at P = 0.05

SWEET CHESTNUT

INVESTIGATOR

Martins, J. Barroso and M. S. Pais.
Mycorrhiza (1996) 6: 265-270.

OBJECTIVE

Evaluate the effect of *Pisolithus tinctorius* inoculation on survival and growth of Sweet Chestnut (*Castanea sativa mill*).

METHODS

Pisolithus tinctorius was introduced into the growth substrate three weeks before plant transfer by introducing five inoculant plugs (0.5 cm^2) of mycelium grown on Modified Melin Norkans (MMN) agar medium. Plants were transferred in the pots four weeks after root induction. Weaning in pots occurred for ten weeks. Roots were monitored and assessed for mycorrhizal symbiosis. Plant survival was evaluated in ex-vitro conditions 10 weeks after transfer.

RESULTS

Plant survival increased significantly after mycorrhization (Table 1). Fresh weights (Table 2) were significantly higher with MYCORRHIZAE treatments and the leaf area of mycorrhizal plants were higher at all monitoring periods (Table 3). Results showed that mycorrhization improves the general condition of micropropagated chestnut plants, increases survival and growth.

Table 1

Percentage of survival of micropropagated mycorrhizal and control plants, before and after weaning

Treatment	Before weaning	After weaning
with MYCORRHIZAE	80.3 b	72.2 b
without MYCORRHIZAE	62.9 a	49.4 a

Mean values within a sampling followed by different letters are statistically different at $P < 0.05$

Table 2

Fresh weights (g) of roots, shoots, leaves and stems of inoculated and non inoculated trees.

Treatment	Roots	Shoots	Leaves	Stems	Plants	Shoot/Root	Leaf/Stem
with MYCORRHIZAE	114.46 b	233.70 b	96.93 b	91.56 b	348.15 b	2.01 b	1.06 b
without MYCORRHIZAE	51.56 a	175.90 a	51.08 a	76.35 a	218.48 a	3.4 a	0.67 a

Mean values within a each parameter followed by different letters are statistically different at $P < 0.05$

Table 3

Leaf area (cm^2) of plants inoculated and non inoculated with *Pisolithus tintorius* 18, 25 and 30 weeks after weaning.

Treatment	18 weeks		25 weeks		30 weeks	
	Total	Leaf area/leaf	Total	Leaf area/leaf	Total	Leaf area/leaf
with MYCORRHIZAE	1063.5 b	76.0 b	2197 b	115.7 b	2680.9 b	167.6 b
without MYCORRHIZAE	360.3 a	37.9 a	1005.8 a	73.2 a	1280.2 a	91.4 a

Mean values followed by different letters are statistically different at $P < 0.05$

GRAPE VINE

INVESTIGATOR

Dr Gene Safir, Michigan State University, MI • 1992

OBJECTIVE

Evaluate the establishment success of grafted *Vitis vinifera* grape cuttings in response to inoculation with *Glomus intraradices*.

METHODS

One year old grape vine rootstock 3309 grafted with Chardonnay grape variety was inoculated at the same time as the vines were outplanted in May 1991 at Château Grand Traverse, Michigan. *Glomus intraradices* inoculum was incorporated in each planting hole.

In addition to the mycorrhizal treatment, two controls were included in the trial. A treatment consisting of the same carrier as the mycorrhizal treatment but without the inoculum and a control which represents the normal practice, e.g. mineral soil without any amendment. The carrier consisted of perlite and peat moss.

RESULTS

The growth results (Table 1) showed that the mycorrhizal inoculated plants did sustain greater vine shoot length (P = 0.05) during the first growing season.

Growth enhancement of the outplanted vines was greatest between the control without peat and the mycorrhizal treatment. There seems to be an added benefit to peat substrate, but trials with mycorrhiza mixed with peat had the greatest effect. This led to a higher grape yield (22% higher) during the first years of harvest (Table 2). Mycorrhizae treatment was more effective for growth than the indigenous mycorrhizal species and also colonized root system more rapidly.

Table 1

Shoot length and colonization of grafted vine after one growing season in the field.

Treatment	Shoot length /vine (cm)	Colonization (%)
with MYCORRHIZAE	44.5 b	20 b
without MYCORRHIZAE	38 a	1 a

In each column, values with different letters differ significantly. (Student test, P = 0.05)

Table 2

Effect of mycorrhizae on grape yield.

Treatment	kg/10 plants
with MYCORRHIZAE	58.43 b
without MYCORRHIZAE	47.73 a

In each column, values with different letters differ significantly. (Student test, P = 0.05)

BLACK OAK

INVESTIGATOR

T. Daughtridge, et al., New Phytol., 103 (1986): 473-480.

OBJECTIVE

Evaluate the effect of mycorrhizal inoculation with *Pisolithus tinctorius* on container-grown black oak (*Quercus velutina* Lam.) seedlings.

METHODS

Seeds were stratified and put on moist blotting paper for germination and then sown in 750 cc, three-cavity Spencer-Lemaire root-trainers. Growth medium consisted of a mixture of peat and vermiculite (1:1, v/v) that had been sterilized with methyl bromide. Inoculation was achieved by thoroughly incorporating the vegetative mycelium-peat moss-vermiculite inoculum throughout the growth medium at a rate of 25 cc per container cavity.

Plants were arranged in a completely randomized design in the shadehouse. A total of 11 seedlings were planted per treatment. Each week, from day 31 of the experiment, seedlings of each treatment were randomly harvested until 19 weeks after planting. Dry weights of leaves, stems and roots were recorded after drying for 72 h in a forced-draft oven at 80°C. Seedling leaf area were measured with a leaf area meter (model Li-3000, Li-Cor, inc.).

RESULTS

For the entire experiment, the relative growth rate of seedlings treated with *Pisolithus tinctorius* was significantly greater than that of non treated seedlings (Table 1). This experiment has demonstrated that growth of black oak seedlings is stimulated by the mycorrhizal symbiosis. Growth analysis indicated that this superior growth was attributable to an increase in the leaf area per unit plant dry weight.

Table 1

Total dry weight and total leaf area for mycorrhizal and non mycorrhizal black oak *(Quercus velutina)* seedlings.

Treatment	Total leaf area (cm^2)	Total dry (g)
with MYCORRHIZAE	325.4 b	10.0 b
without MYCORRHIZAE	131.8 a	4.6 a

In each column, values with different letters differ statistically. (LSD Test, $P \leq 0.05$)

CITRUS

INVESTIGATOR

Katherine Clough et al., Premier Tech, QC

OBJECTIVE

Evaluate the growth improvement of two citrus rootstock cultivars inoculated with *Glomus intraradices.*

METHODS

Peat based mixes were prepared with *Glomus intraradices* and a non-inoculated control. Mixes were limed in order to have suitable pH for citrus growth. Seeds from rootstock Carrizo citrange were sown prior to the experiment. Once seedlings had reached 12-15 cm in height they were transferred to 8 inches pots filled with the inoculated or non-inoculated peat mix. The experimental design was a complete block with six replicates for each treatment. Plants were put in a greenhouse and harvested four months later. Low phosphorus fertilizers were used weekly.

RESULTS

Mycorrhizae had a significant, positive effect on the dry weight of the rootstock (Table 1). An increase of 111% was obtained after four months of growth.

Table 1

Dry weight (g) of four-month old citrus plants.

Treatment	Weight (g)
with MYCORRHIZAE	3.06 b
without MYCORRHIZAE	1.70 a

Values with different letters differ significantly at P = 0.05

MORNING GLORY

INVESTIGATOR

Fred Davies et al. Texas A & M University • 2000

OBJECTIVE

Determine the quality of nursery grown crops used in landscaping with different slow release fertilizers under mycorrhizal symbiosic.

METHODS

This study was conducted under simulated nursery production conditions at the TAMU Nursery and Floriculture Field Complex. Liner plants were transplanted under very high temperature conditions, 43.5 to 47.7°C (110 to 118°F). Uniform mycorrhizal-free rooted cuttings of *Ipomoea carnea* (Bush Morning Glory) were shifted up into N° 1 containers with a substrate mixture of 80% pine bark and 20% sand. The container media was sterilized during two consecutive days for 4 hours.

Inoculation with mycorrhizal fungi was studied with a slow release fertilizer (SRF) applied at three levels (70%, 100% and 140% of the recommended rate [see Table 1.]) and an inorganic slow release fertilizer (osmocote) at 50% and 100% of the recommended rate. Phosphorus levels of the low and high organic SRF were deliberately matched with the 2 levels of the inorganic SRF.

Plants were irrigated as needed. Irrigation was applied via spot spitters (Roberts Irrigation Products, San Marcos, Calif.). The irrigation water was adjusted to pH 6.5 via injection of sulfuric acid.

Experimental design was a factorial experiment with 2 mycorrhizal treatments (with and without) and 5 fertility levels.

Plants were harvested and evaluated at 51 to 53 days after transplanting.

RESULTS

In general, mycorrhizae enhanced leaf, root, shoot and total plant dry mass of Bush Morning Glory regardless of the inorganic or organic SRF (Table 1). The high level of inorganic SRF (100% recommended level) with mycorrhizae was the best treatment. The 140% organic SRF gave the poorest due to excessive fertility levels; however, mycorrhizal plants at this level did better than non-colonized plants.

Root colonization levels were highest (21%) with the 70% organic. However good colonization (14%), hyphae and arbuscule development occurred at the high level of inorganic SRF (100% recommended level).

Regardless of mycorrhiza or fertility, media temperatures were uniformly high and ranged from 43.5 to 47.7°C (110 to 118°F). Even at these high temperatures colonization and growth enhancement occurred with the inoculated plants.

Table 1

Effect of fertility and mycorhizae on root, leaf, shoot, and total plant dry mass (DM) of container grown Bush Morning Glory.

	Fertility source	Shoot DM (g)	Root DM (g)	Leaf DM (g)	Total DM (g)
with MYCORRHIZAE	Nitrell 70%	11.51	5.04	2.53	16.55
without MYCORRHIZAE		7.53	3.36	1.76	11.15
with MYCORRHIZAE	Nitrell 100%	10.04	5.09	4.98	15.13
without MYCORRHIZAE		8.38	4.62	2.48	12.99
with MYCORRHIZAE	Nitrell 140%	6.25	3.39	1.93	9.65
without MYCORRHIZAE		2.98	1.21	1,03	4.2
with MYCORRHIZAE	Osmoc. 50%	13.78	7.07	2.76	20.84
without MYCORRHIZAE		6.81	2.71	1.65	9.52
with MYCORRHIZAE	Osmoc. 100%	19.67	9.91	4.98	29.58
without MYCORRHIZAE		9.73	4	2.82	13.73
Significiance					
MYCORRHIZAE treatment		***	***	***	***
Fertility		**	***	***	***
AMF X Fertility (Interaction)		***	***	**	***

** = Significant at 1%, *** = significant at 0.1%

MAGNOLIA

INVESTIGATOR

Peter M. Shaw, Washington State University, WA

OBJECTIVE

Compare the growth of magnolia with and without *Glomus intraradices* using different fertilizers and growing media.

METHODS

Uniform rooted cuttings of *Magnolia stellata* obtained from Monrovia Nursery (Dayton, OR), were transplanted into 1.18 l plastic containers. The experiment included 30 different treatments; Five growing media, three levels of fertilization and two mycorrhizal treatments (with and without mycorrhizae).

Material used for media preparation:

Sphagnum peat moss based growing medium (PREMIER) (M) • Douglas fir bark (B) • Sand (S)

Media preparation:

$_1$M: $_1$B: $_1$S (MBS) • $_3$B: $_1$S (BS) • $_1$M: $_1$B (MB) • $_1$M: $_1$S (MS) • (M)

Each mycorrhizal treatment received mycorrhizal inoculum and the non-mycorrhizal treatments received a filtrate (filtered through a 5 mm membrane in order preserve the microflora) of the inoculum. The inoculum, or filtrate, was placed in the planting holes directly under the plants prior to transplanting. After planting, 3 g, 5 g or 7 g Osmocote (18-6-12) was top dressed on each container according to their treatment.

Plants were grown in a greenhouse until spring then moved to a lath house for hardening-off and then to a gravel nursery bed. Plants were watered as needed with drip irrigation in the greenhouse and with overhead irrigation outdoors. Two applications of 200 ppm of N from Peter's 20-0-20 and 20-20-20 fertilizers were applied to the mycorrhizal and non-mycorrhizal plants, respectively.

After seven months growth, the aerial portions of the plants were removed from the roots and fresh weights were measured. The roots were washed from the growing media and a sample was taken for mycorrhizal colonization determination. After air-drying for one hour, root fresh weight was measured. Roots and shoots were oven dried at 60°C for 4 days, or until stable dry weights were obtained.

RESULTS

Mycorrhizae increased shoot and root dry weights of plants grown at all three ferti-lizer rates. (Table 1). At the highest fertilizer rate, colonized plants sustained higher dry weight yield with the exception of those which grew in Douglas fir bark.

These results clearly show that an ideal fertilization for good plant growth can be compatible with mycorrhizae inoculation in nursery pot grown magnolia. A close watch on plant nutrient requirements and a good monitoring of nutrients in the leachate, to prevent nutrient build up, are the best practices for optimal use of mycorrhizae with magnolia. By reducing the fertilizer rate, a lower nutrient charge is obtained in the leachate while the growth of magnolia continues to be acceptable for growers.

Table 1

Effect of fertilizer rate on shoot and root dry weight of mycorrhizal and non mycorrhizal Royal Star magnolia. (pooled data for the 5 media)

	Shoot dry weight (g) Fertilizer rate (g)/container			Root dry weight (g) Fertilizer rate (g)/container		
	3	5	7	3	5	7
with MYCORRHIZAE	15.5 b	22.2 b	29.3 b	18.4 b	23.6 b	31.4 b
without MYCORRHIZAE	13.9 a	20.3 a	25.2 a	16.8 a	23.0 a	27.6 a

In each column, values with different letters differ significantly at P = 0.05

MYKE® Pro

GREENHOUSE CROPS

Using mycorrhizal fungi gives greenhouse growers an opportunity to reach their goal: customer's satisfaction! By delivering healthy and drought resistant plants.

GERANIUM

INVESTIGATOR

Peter M. Shaw et al.,
Washington State University, WA

OBJECTIVE

Compare vegetative growth, flowering and colonization of geraniums grown in commercial greenhouse with growing media inoculated with *Glomus intraradices*.

METHODS

Pelargonium hortorum Bailey Sprinter Scarlet were sown in flats. Seedlings were transplanted into 1.18 l plastic pots containing PRO-MIX®.

Prior to planting, mycorrhiza inoculant was placed in planting holes. The non-mycorrhizal treatment received the same inoculum but was inactivated by autoclaving it for one hour. Five grams of Osmocote 18N-2.4P-10K (18-6-12) were top dressed in each pot after transplanting.

There were five pots for each treatment. A randomised complete block design was set up in a greenhouse with supplemental lighting HID (320 mmol s-1). Plants were watered when needed with overhead irrigation. A supplemental feeding of 100 mg l-1 of 20-8.7-16.6 (N-P-K) was applied seven weeks after planting when the plants showed signs of nitrogen deficiency.

Plants were harvested when the first floret opened, allowing for a comparison of treatments at the same stage of plant maturity. At harvest, the number of days to flowering, shoot and root fresh weights, height and width at the two widest points were recorded. Developmental stage of the inflorescence was categorised as follows: one open floret, inflorescence above the foliage but no florets open and inflorescence visible.

RESULTS

Results of analysis of variance indicated significant differences due to mycorrhizae for the number of ramifications, days to flowering, number of visible inflorescence, lateral branch length and number of flowers per plant (Tables 1-4). However, other parameters monitored such as shoot and root fresh or dry weight, plant height, width, leaf area and leaf number (data not shown) did not vary significantly due to mycorrhizal colonization.

The effect of mycorrhizal fungi on flowering (Table 1) may be directly related to lateral branch development and overcoming apical dominance. Other results obtained with commercial growers have shown that increased ramifications are a major effect encountered with mycorrhizae.

Table 1

Effect of mycorrhizae on days to flowering of Sprinter Scarlet geranium.

	Number of days
with MYCORRHIZAE	99.a
without MYCORRHIZAE	105.8 b

In each column, values with different letters differ significantly at P = 0.05

Table 2

Effect of mycorrhizae on lateral branch development of Sprinter Scarlet geranium.

	< 5 cm	2.5 - 4.9 cm	<2.5 cm
with MYCORRHIZAE	4.5 b	5.7 a	4.7 a
without MYCORRHIZAE	2.9 a	7.6 b	3.9 a

In each column, values with different letters differ significantly at P = 0.05

Table 3

Effect of growing medium and mycorrhizal fungi treatment on the number of inflorescences visible below the foliage of Sprinter Scarlet geranium.

	Number of inflorescence
with MYCORRHIZAE	1.7 b
without MYCORRHIZAE	1.2 a

In each column, values with different letters differ significantly at P = 0.05

Table 4

Effect of mycorrhizal fungi treatment on total number of inflorescences on Sprinter Scarlet geranium.

	Number of inflorescence
with MYCORRHIZAE	4.0 b
without MYCORRHIZAE	3.2 a

In each column, values with different letters differ significantly at P = 0.05

ALLEGHENY SPURGE AND PURPLE CONEFLOWER

INVESTIGATOR

David Douds, USDA, ERRC, Philadelphia PA

OBJECTIVE

Evaluate the effect of mycorrhizal inoculation on growth enhancement of different species of perennials in standard nursery conditions at the Blue Mountain Nursery.

METHODS

Rooted cuttings of Allegheny spurge (*Pachysandra procumbens*) and purple coneflower (*Echinaceae purpurea cv* Bravado) were transferred in a peat based medium. Nutricote (18-6-8) was mixed in the mix at a rate of 8 lbs per cubic yd. Treatments with and without mycorrhizae were used for both plant species. Plants were set up in a complete block experimental design. After potting up the plants, 6 plants per treatment were used at each harvest. Plants were harvested to monitor the root and shoot growth throughout the production period at 9 weeks and 17 weeks after transplantation.

RESULTS

Shoot and root dry weight of Purple coneflower was significantly greater at 9 weeks for the plants with mycorrhizae (Table 1).

The Allegheny spurge had a growth pattern similar to the purple coneflower. Growth parameters measured at both 9 and 17 weeks of growth indicated that both shoot and root weight were significantly higher with mycorrhizae (Table 2).

Table 1

Shoot and root weight (g) of Allegheny spurge after 9 and 17 weeks of growth.

	Shoot weight (g)	
	9 weeks	17 weeks
with MYCORRHIZAE	5.2 b	7.0 b
without MYCORRHIZAE	3.2 a	3.2 a
	Root weight (g)	
	9 weeks	17 weeks
with MYCORRHIZAE	7.0 b	10.0 b
without MYCORRHIZAE	6.0 a	7.0 a

In each column, values with different letters differ significantly (Student's T-Test, P = 0.05)

Table 2

Shoot and root weight (g) of Purple Coneflower after 9 weeks of growth.

	Shoot weight (g)	Root weight (g)
with MYCORRHIZAE	8.0 b	3.7 b
without MYCORRHIZAE	6.1 a	2.9 a

In each column, values with different letters differ significantly at P = 0.05

BOSTON FERN

INVESTIGATOR

François Ponton et al.,
HortScience vol 25 (2) 123-189 February 1990

OBJECTIVE

Evaluate the growth of micropropagated fern in response to mycorrhizal inoculantion.

METHODS

Plantlets were transferred into pots containing a peat moss substrate. Control plants did not receive mycorrhizal inoculant. Plants were grown in a greenhouse under mist for the first five weeks of growth. Afterwards they were grown under normal greenhouse conditions with extended day length to 16 hours per day.

Plants were watered as needed and fertilized weekly with a commercial solution of low phosphorus concentration. Pots were randomly placed in a complete block design with six replicates for each treatment.

One replicate per treatment was harvested after 6, 12 and 18 weeks of growth following inoculation. The root system was measured and roots were stained in order to evaluate their level of colonisation by the inoculant. Plant dry weight was also determined.

RESULTS

After 18 weeks root spread was superior by 30% with mycorrhizae. (Table 1)

Table 1

Effect of mycorrhizae on root spread after 18 weeks.

	(mg) x 100
with MYCORRHIZAE	65 b
without MYCORRHIZAE	48 a

In each column, values with different letters differ significantly (Scott-Knott Test, P = 0.05)

COLEUS AND SALVIA

INVESTIGATOR

Susan Parent et al., Premier Tech, QC

OBJECTIVE

Determine the effect of mycorrhizae on plant ramification of coleus and salvia.

METHODS

Salvia was sown in sphagnum peat moss mix inoculated with *Glomus intraradices*. Rooted cuttings of Coleus (*Coleus blumei*) were also used with the same inoculant. For both plant species, non-inoculated controls were used and cultivated following standard growing practices.

The plants were grown in a greenhouse during the fall and artificial lighting was provided with high pressure sodium lamps. The experimental design was a complete randomized block with six replicates per treatment. The plants were harvested after 8 weeks for the salvia and 15 weeks for the coleus.

RESULTS

Number of plant ramifications had increased significantly from 6 to 7.5 and from 8.6 to 11 for salvia and coleus respectively when they were treated with the mycorrhizal inoculant (P = 0.05) (Table 1).

Table 1

Effect of mycorrhizae on the number of ramifications for coleus and salvia.

	Coleus	Salvia
with MYCORRHIZAE	11.0 b	7.5 b
without MYCORRHIZAE	8.6 a	6.0 a

In each column, values with different letters differ significantly at P = 0.05

GERBERA

INVESTIGATOR
Huiming Wang et al., Laval University, QC

OBJECTIVE
Determine the effect of mycorrhizae on the survival and growth of gerbera produced by tissue culture.

METHODS
The substrates used in the experiment consisted of 75% Canadian sphagnum peat moss and 25% vermiculite. *Glomus intraradices* was used to inoculate the experimental substrates and the non-inoculated treatment was used for control.

Vitro-plants of gerbera were transferred from test tubes to substrates in Cell Pack multicell containers (~100 cm-3).

An acclimatization period of six weeks was maintained in a small plastic tunnel with a mist in the first two weeks. Afterwards, the plants were transplanted in 10 cm pots and transferred to a greenhouse for 11 weeks. Plants were watered as needed and fertilized weekly with 100 ml commercial fertilizer which contained per liter 480 mg of $mgSO_4.H_2O$, 750 mg of $Ca(NO_3)_2.4H_2O$, 31.4 mg of 10-52-10 (Plant Products Co. Ltd., Bramalea, ON, Canada) and 550 mg of 12-0-44 (Plant Products Co. Ltd.).

The growth response was measured by harvesting one random replicate of each treatment in each block 4, 8 12 and 16 weeks following inoculation. The plant tissues were oven-dried for 72 h at 65°C (105°F) before dry weights were recorded.

RESULTS
The plants treated with mycorrhizae did generally better for all growth parameters observed in comparison to the treatment without mycorrhizae (Table 1).

Table 1
Effect of mycorrhizae on tissue-cultured[1] gerbera.

Week	Treatment	LDW (g)	RDW (g)	No Leaf	Leaf length (cm)	SL (g)	No Flower
4	with MYCORRHIZAE	0.19 b	0.06 a	5.56 a	5.21 b		
	without MYCORRHIZAE	0.15 a	0.06 a	5.22 a	3.97 a		
8	with MYCORRHIZAE	2.94 b	0.70 b	10.56 b	23.78 b		
	without MYCORRHIZAE	2.24 a	0.52 a	9.44 a	20.72 a		
12	with MYCORRHIZAE	9.58 b	4.91 b	11.22 b	32.33 b		
	without MYCORRHIZAE	8.19 a	4.54 a	10.11 a	28.53 a		
16	with MYCORRHIZAE	16.25 b	5.78 b	12.00 b	32.38 b	97.22 b	6.21 b
	without MYCORRHIZAE	12.73 a	5.16 a	11.00 a	31.28 a	80.93 a	4.40 a

For each sample and date values with different letters differ significantly (Duncan's multiple range test, P = 0.05)

LDW: Leaf dry weight
RDW: Root dry weight
SL: Shoot length

POINSETTIA AND GERANIUM

INVESTIGATOR

Susan Parent and Ed Bloodnick, Bird-in-Hand, PA

OBJECTIVE

Compare the growth of poinsettia and geranium cultivated with and without mycorrhizae when grown in a peat based mix.

METHODS

Poinsettia and geranium cuttings were previously rooted before sticking them in one of the mixes used for the trials. Geranium were grown in 8 inch pots (azalea type) and poinsettia in smaller 6 inch pots (azalea type). The temperature was kept at 24 to 29.5°C (75 to 85°F) during the day and at 21°C (70°F) at night for the geranium. For the poinsettia, day temperature was kept at 26.5 to 35 °C (80°-95°F) during the first 4 weeks and at a maximum of 24°C (75°F) during the last 10 weeks. Night temperature for the same periods was kept at 20-21°C and 15.5-16.5°C (68-70°F and 60-62°F) respectively.

Fertigation practices were used with commercial fertilizers. The mycorrhizal plants were fertilized with a 20-2-20 (Plantex/Plantco Inc.) prepared in order to have a concentration of 200 ppm of nitrogen. Non-mycorrhizal plants received a fertilizer with more phosphorus, 20-10-20 which was applied at the same nitrogen rate as 20-2-20. Irrigation solution was applied with a drip tube irrigation system.

The geranium trial involved transplanting 600 geraniums into each of the growing media (1 200 total). As for the poinsettia trial, 3 000 poinsettias were used (1 500 for each growing media).

For the Poinsettia trial, 20 plants were monitored from each group throughout their growth for the number of leaves, plant height, bract width and number of colored bracts. Whereas for the geranium, 10 plants from each group were used to evaluate the quantity of cuttings produced. At the end of the trial (14 weeks for poinsettia and 32 weeks for geranium), fresh weight was registered for poinsettia only.

RESULTS

Poinsettia showed many different cultural advantages when grown with mycorrhizae. The bracts and width of the plants were generally more important, root fresh weight and appearance were superior when inoculated (Tables 1 and 2). Geranium cuttings were more numerous when grown with mycorrhizae (Table 3).

Table 1

Effect of mycorrhizae on poinsettia growth parameters.

Treatment	Plant height (in)
with MYCORRHIZAE	10.7 b
without MYCORRHIZAE	9.5 a
Treatment	**No. of leaves**
with MYCORRHIZAE	41.8 b
without MYCORRHIZAE	35.5 a
Treatment	**Bract width (in)**
with MYCORRHIZAE	7.7 b
without MYCORRHIZAE	6.56 a

For each perameter, values with different letters differ significantly (Duncan's test, P = 0.05)

Table 2

Effect of mycorrhizae on other poinsettia growth parameters at five sampling dates.

	Oct. 23	Nov.6	Nov.12	Nov.21	Dec.18
Number of colored bracts					
with MYCORRHIZAE			32.6 b		113.5 b
without MYCORRHIZAE			19.2 a		96.0 a
Plant width					
with MYCORRHIZAE	13.2 a	16.4 b	16.1 b	17.7 b	17.7 b
without MYCORRHIZAE	12.5 a	13.9 a	13.8 a	14.5 a	14.4 a
Root fresh weight					
with MYCORRHIZAE			22.2 b	29.4 b	
without MYCORRHIZAE			18.8 a	18.3 a	

For each parameter and date In each column, values with different letters differ significantly at P = 0.05

Table 3

Effect of mycorrhizae on the average number of geranium cuttings.

	Number of cuttings
with MYCORRHIZAE	3.3 b
without MYCORRHIZAE	2.7 a

In each column, values with different letters differ significantly at P = 0.005

CARROT, LEEK, STRING BEANS AND GREEN PEPPER

INVESTIGATOR

Julie Ouellet, Premier Tech, QC

OBJECTIVE

Evaluate the growth improvement of certain vegetable crops seeded and transplanted in the field with mycorrhizae.

METHODS

Transplants and seeds were planted and sown respectively in the field according to the crop requierements. The experimental design was a randomized complete block with four replicates. The field soil was tilled and leek, string beans and green pepper plant received an organic granular ferti-lizer (5-6-1) at the beginning of the experiment at the rate of 10 g per transplant and 125 g per meter of row for seeded crop. Carrots were sown in soil which had been fertilized as recommended by the "Conseil des productions végétales du Québec" (CPVQ) with half the recommended phosphorus.

For each crop species, a non-mycorrhizal and a mycorrhizal treatment were used. Mycorrhizal inoculant was incorporated in the soil at a rate of 45 ml for transplanted crops and 10 ml per meter of row for seeded crops. For control crops, no MYCORISE® was introduced to the soil.

During the growing season, pepper and bean pod were harvested weekly until the end of production. Carrots and leeks were harvested at the end of the season, just before frost.

RESULTS

Mycorrhizae had a significant, positive effect on the pod number of string beans (Table 1). Plants produced 17% more pods when they were inoculated with MYCORISE® compared to the control and increased pod weight by 25%(Table 2).

Green peppers showed very good response to the mycorrhizal treatment (Table 3). Plants produced 64% more fruits when inoculated with mycorrhizal fungi. However pod weight of green peppers was greater with mycorrhizae but not significantly different.

In the field, leeks produced a greater percentage of marketable stalks with the mycorrhizal treatment. Stalks that were considered marketable had a diameter of 2.5 cm (1 inch) or more. The plants treated with mycorrhizae had 54% (Table 4) more marketable stalks in comparison to the treatment without mycorrhizae.

Carrots showed a significant difference between yield of treated and control crops. Control treatments generated 88.01 tons/ha and the mycorrhizae treatment generated 100.54 tons/ha. This 14% increase in yield was obtained in mineral soil in the Quebec city area. (Table 5)

Table 1

Effect of mycorrhizal treatment on the pod number of string beans after the growing season in field.

Treatments	Number of pod /plant	Increase (%)
with MYCORRHIZAE	64.45 b	17%
without MYCORRHIZAE	55.07 a	-

Values with different letters differ significantly (LSD Test, P = 0.05)

Table 2

Effect of mycorrhizal treatment on pod weight of string beans after the growing season in a field.

Treatments	Pod weight (g) /plant	Increase (%)
with MYCORRHIZAE	454.20 b	25%
without MYCORRHIZAE	363.55 a	-

Values with different letters differ significantly (LSD Test, P = 0.05)

Table 3

Effect of mycorrhizal treatment on the number of green peppers after the growing season.

Treatment	Fruit number/plant
with MYCORRHIZAE	2.3 b
without MYCORRHIZAE	14 a
Treatment	**Increase (%)**
with MYCORRHIZAE	64%
without MYCORRHIZAE	-
Treatment	**Fruit weight/plant (g)**
with MYCORRHIZAE	350.00 a
without MYCORRHIZAE	231.25 a

For each parameter values with different letters differ significantly (LSD Test, P = 0.05)

Table 4

Effect of mycorrhizal treatment on the percentage of marketable leek stalks after the growing season.

Treatments	% marketable stalks	Increase (%)
with MYCORRHIZAE	87.0 b	54%
without MYCORRHIZAE	56.4 a	-

Values with different letters differ significantly (LSD Test, P = 0.05)

Table 5

Effect of mycorrhizal treatment on the yield of carrots after the growing season.

Treatments	Yield (tons/ha)	Increase (%)
with MYCORRHIZAE	100.54 a	14%
without MYCORRHIZAE	88.01 b	-

Values with different letters differ significantly (LSD Test, P = 0.05)

ONION

INVESTIGATOR

Maria de los Angeles Jaime, Tom Hsiang, Mary Ruth McDonald, Guelph University, Guelph, ON

OBJECTIVE

Evaluate management possibilities of white rot for onions grown in organic soils, through the use of biological controls such as mycorrhizal inoculant.

METHODS

Onions, cultivars Fortress (relatively resistant mid-maturing) and Hoopla (relatively susceptible mid-maturing) were seeded in 288 plastic plug trays on April 18-19, 2000. Mycorrhizal inoculum *Glomus intraradices* was used as seed treatments. PRO-MIX PGX® was used as the growing medium for all treatments.

The fertilizer regime for all treatments was potassium nitrate 13.5-0-46 (greenhouse grade 50 ppm the first time and 100 ppm for the other application), once a week, starting 2.5 weeks after seeding. The plants remained in the greenhouse for 5 weeks. The tops were clipped at 4, 5 and 6 weeks to prorote larger onions. The plants were placed outside for one week to harden before transplan-ting. Lorsban for onion maggot control was applied (1.6 ml in 500 ml of water per tray) before hand-transplanting.

Trials were located in three naturally infested commercial fields (muck soil, pH 6.4, organic matter 60%) in Bradford Marsh, Ontario, Canada. The onion plants were hand transplanted on May 29-30 (Site 1), June 5-6 (Site 2) and June 7 (Site 3). The seven treatments tested (Table 1) were replicated six times for each cultivar in a randomized complete block design. Each plot in the trial consisted of one bed of four rows of onions (2 m) with a row spacing of 0.42 m (1.7 m wide). Onions were planted at 25 plants/m, giving 200 onions per plot. Recommended control procedures for fungal and bacterial pathogens, weeds and insects were followed. Tebuconazole (1 L/ha) Folicur 3.6 F was applied in band twice, 5 and 10 weeks after hand-transplanting (Davies et al., 1998).

Assessment before transplanting and mid-season (8 weeks) was done to measure the percent of root colonization by mycorrhizal fungi, the weight (fresh and dry) and the size of the plants. Periodic subsamples at 6, 9, 12 and 15 weeks were collected to monitor the development of the crop. Onion bulbs were assessed for white rot incidence and severity at maturity (15 weeks) as well as weight (fresh and dry). White rot incidence was classified as low (1- 10%), medium (11-50%) and high (51-100%).

RESULTS

Weather conditions during the growing season were wet and cold which was favorable for the development of white rot and other fungal and bacterial diseases. The first onion infected with white rot was found on July 6, 2000. In two of the three fields the disease incidence was greater than 20% (Site 1 & Site 3). At Site 2, the incidence of the disease was less than 2%; no significant differences were found among treatments in Site 2. Data are shown from Site 1 and 3 (Table 1). Disease incidence at the two sites was 22.3% (Site 1) and 36.4% (Site 3). In this area, the average disease incidence in commercial production was approximately 35%. In some commercial fields white rot incidence was 75% for the 2000 season.

Disease incidence was higher in cv. Hoopla (30.01% Site 1, 37.42 % Site 3) than in cv. Fortress (5.76% Site 1, 12.64% Site 3). These data confirm the higher susceptibility of Hoopla and the partial resistance of Fortress to white rot.

The two applications of Folicur reduced white rot incidence at harvest compared to the control by more than 45%. Similar results were found with tebuconazole in field trials in 1999 (McDonald, et al., 1999). Beneficial effects were observed in onion plants grown with mycorrhizal inoculant in terms of reduced incidence of the disease. White rot incidence at harvest was significantly reduced by more than 45%. This treatment did not differ significantly from the fungicide in terms of

disease incidence. These data suggested that *Glomus intraradices* can colonize and protect onions from white rot when the plants are inoculated before coming into contact with the pathogen.

Table 1

Mean percentage of white rot incidence and marketable onions (mean value of both cultivars).

			Site 1		Site 3	
Treatment[1]	Rate	Active ingredient	% Disease	% Marketable	% Disease	% Marketable
Conrol (untreated)			22.30 c	85.70 c	26.76 c	83.20 c
Folicur 3.6 F[2]	1 L/ha	Tebuconazole	11.58 a	93.74 a	15.61 a b	91.14 a b
MYCORRHIZAE	1 000 spore/l	Glomus intraradices	14.94 b	92.04	18.54 a b	87.71 a b c

1 Except for the fungicide Folicur which was dand sprayed 5 and 10 week after transplant, other treatments were on seeds. In each column, values with different letters differ significantly (Fishers Protected LSD Test, P = 0.05)

ASPARAGUS

INVESTIGATOR

Christian Pedersen et al.,
Plant and Soil 135, pp. 75-82

OBJECTIVE

Evaluate the effect of mycorrhizae on micropropagated and seeded asparagus.

METHODS

Mycorrhizal inoculant was introduced to micropropagated asparagus when the plantlets were transferred to a peat moss substrate. Plants were covered with a plastic lid for four days. Subsequently, plants were transferred to a greenhouse bench covered with a heavy shade cloth. Eight days later, the plastic lid and shade cloth were removed.

For the seeded asparagus cv Mary Washington, three week old seedlings were transplanted into the peat-based substrate containing Mycorrhizal inoculant. Plants were set up in a completely randomized design with eight replicates per treatment.

Plants were watered as needed and fertilized weekly. After 16 weeks, the plants were harvested, plant dry weight, fern and bud numbers were measured. The same treatments for the greenhouse study were also prepared for a study that took place in field experiments the field soil was previously fumigated with methyl bromide. After 12 weeks in the field, five plants were harvested for root colonization evaluation and for other plant growth parameters.

RESULTS

In the greenhouse experiment, micropropagated plant dry weight was increased by 43% (Table 1) when plants were treated with mycorrhizal inoculant. In the field study (Table 2), the survival of micropropagated plants treated with Mycorrhizal inoculant after 14 months was 50% while the survival of the controls was 38%. For the seeded plants, survival was 30% compared to 8% for the control treatment.

Table 1

Asparagus dry weight after 12 weeks in the greenhouse

Treatments	Dry weight (g)
with MYCORRHIZAE	61.8 b
without MYCORRHIZAE	43.3 a

Values with different letters differ significantly at P = 0.05

Table 2

Asparagus survival 14 monts after planting in the field.

Treatments	Seeded (%)	Micropropagated (%)
with MYCORRHIZAE	30 b	50 b
without MYCORRHIZAE	8 a	38 a

In each column, values with different letters differ significantly at P = 0.05

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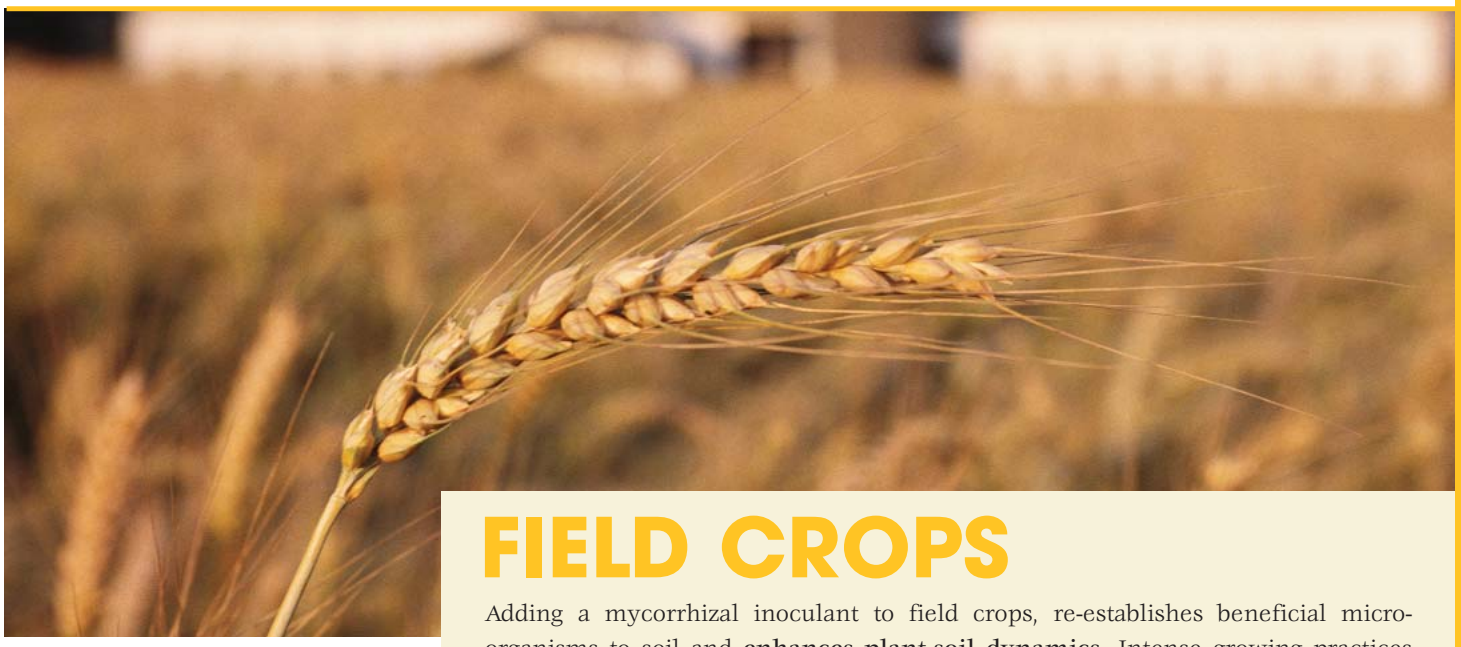

FIELD CROPS

Adding a mycorrhizal inoculant to field crops, re-establishes beneficial micro-organisms to soil and **enhances plant-soil dynamics**. Intense growing practices and crop rotations with non-mycorrhizal plants lead to significant reductions in the naturally occurring mycorrhizal fungi in soils. Restoring these fungi back in soils will allow plant roots to be in contact with them from the beginning of growth, and therefore benefit from the advantages of mycorrhizal symbiosis.

SOYBEAN

INVESTIGATOR

Andrée Deschênes et al. Premier Tech, Brazil.

OBJECTIVE

Evaluate the effect of *Glomus intraradices* on the growth of soybean (*Glycine max*) on a large-scale production.

METHODS

Soybean seeds of the variety: Vencedora BRS-MG-68 were directly sown on corn stubble) at 50 kg / ha in Uberaba, Brazil. Mycorrhizal inoculant was applied, at recommended rate, to test seeds 2 hours prior to seeding.

All test and control seeds were supplemented with the following products:

- Vitamax-Thiram 300 ml/100 kg
- Regente 30 g/100 kg
- Manganese 1 L/100 kg
- Nitragin Soybean Inoculant 300 ml/100 kg

Plants were harvested at the end of the growing season and plant density, pods per plant, pods per square meter, grain weight, yield and number of nodules were recorded.

RESULTS

Soybean responded positively in all measured parameters except for the number of pods per plant (table 1). Plant density, increased by 9.8%, 16.4% increase on the number of pods per square meter, 5% on grain weight, 16% on yield and 122% on nodule per meter of row.

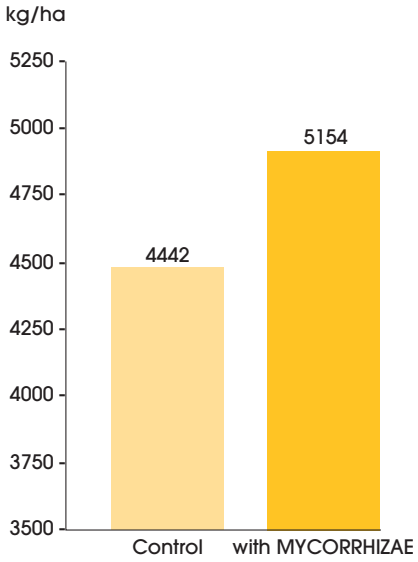

Figure 1
Effect of mycorrhizal inoculation on Soybean yield.

Table 1
Effect of mycorrhiza inoculation on soybean in Brazil.

	with MYCORRHIZAE	without MYCORRHIZAE	
Plant density/ha	250 000	227 788	+ 9.8%
Pods per plant	57.5	58.8	- 2.2%
Pods per square meter	1558.8	1 339.3	+ 16.4%
Grain weight per plant (g)	20.50	19.53	+ 5%
Yield kg/ha	5 154	4 4442	+ 16%
Bradyrhizobium root nodules per meter of row	3 408	1 533	+ 122%

SPRING WHEAT

INVESTIGATOR

Domonique LeQuéré, Premier Tech and Saskatchewan Wheatland conservation area.

OBJECTIVE

Evaluate the effect of mycorrhizal inoculation on winter wheat yield in southern Saskatchewan.

METHODS

Trials were carried out in the Saskatchewan brown soil zone at Swift Current. The wheat cultivar A.C. Barrie was seeded on canola stubble. Two fertilization rates were used, the recommended rate for this area and half the rate (120 and 60 lbs/a of 30-15-0-5). Two levels of mycorrhizal inoculant, 0 or 125 mg /m^2 were also used. The four treatments were arranged in a randomized complete block design with 8 replicates. Plot size was 8 rows wide and 18 feet long. Powder mycorrhizal inoculant was mixed with the seeds at seeding time. Fertilizer was applied simultaneously as a side dress in the furrow. Sowing and harvest dates were May 12 and September 22 respectively.

Plant root colonization was monitored during the season and the yield was recorded at harvest.

RESULTS

Increase in root colonisation and yield were observed with mycorrhizal inoculation (Table 1).

Wheat responded to the fertilization by an increase of yield with the 120 lbs/acre rate. The season 2005 was not very dry; the soil had a good water reserve from winter precipitations and the crop has probably used most of the applied fertilizer. A yield increase of 10% was reached with mycorrhizal inoculation compared to the control at the fertilization rate of 120 lbs/acre.

Table 1

Effect of fertilization rate and application of a mycorrhizal inoculant on root colonization and yield of spring wheat grown in Swift Current, Saskatchewan.

Fertilization (lbs/a)	Mycorrhizal inoculant rate (mg inoculant/m^2)	% colonised roots	Yield (bu/a)
60	0	5.88 a	25.63 a
60	125	15.13 b	25.58 a
120	0	7.00 a	29.17 b
120	125	12.00 b	32.17 c
		*	*

*Data followed by different letters are significantly different according to Duncan's test at p≤0.05.

PULQUE AGAVE

INVESTIGATOR

Marc Beland et al. Premier Tech Biotechnologies, 2005

OBJECTIVE

Demonstrate the benefits of mycorrhizal inoculation on Pulque Agaves (*Agave salmiana*) in a forestry nursery in Mexico.

METHODS

Mycorrhizal inoculation was done on germinated seedlings (10 weeks old) at Revolution nursery in March 2004. Fungal inoculum of *Glomus intraradices* was added or not to 5 ml of water and applied with a custom hand sprayer individually to seedlings. Mycorrhizal inoculum was added according to the following recommendations:

Spores 1 = 75 spores per plant
Spores 2 = 150 spores per plant

There were 462 seedlings per tray and six trays per treatment. Eight individuals per tray were harvested after 16 weeks; measurement of their height, collar diameter, fresh weight, aerial fresh/dry weight, root fresh/dry weight was taken.

RESULTS

Agave salmiana responded very well to mycorrhizal inoculation with Glomus intraradices. Significant increases in all growth parameters measured were observed between mycorrhizal and non-mycorrhizal plants (table 1). There was no significant difference in plant response between both levels of inoculum added. Significant increases for collar diameter (14%), height (17%), total fresh weight (49%), aerial fresh weight (50%) and root fresh weight (40%) were recorded for mycorrhizal plants. *Agave salmiana* is a cactus-type plant that has a fibrous root system that is highly responsive to mycorrhizal inoculation, increasing root biomass, particularly in-creasing the number of fine feeder roots.

Picture 1
General appearance of *Agave salmiana* exposed to various treatments.

Table 1
Agave salmiana growth characteristics after 16 weeks post inoculation in the nursery.

Treatment	Avr collar diameter (mm)	Avr plant height (cm)	Avr fresh wt (g)	Avr fresh aerial wt (g)	Avr fresh root wt (g)	Avr dry aerial wt (g)	Avr dry root wt (g)
Control	17.37 a	4.84 a	67.71 a	33.14 a	4.56 a	1.72	0.33 a
Glomus intraradices (spores 1)	19.57 b	5.76 b	56.38 b	49.95 b	6.39 b	2.29	0.59 b
Glomus intraradices (spores 2)	19.87 b	5.6 b	56.15 b	49.51 b	6.45 b	2.05	0.57 b
	$p < 0.001$	$p < 0.001$	$p < 0.001$	$p < 0.001$	$p < 0.001$	$^{**}p = 0.05$	$^{*}p < 0.001$

For each parameter and treatment,values with different letters differ significantly

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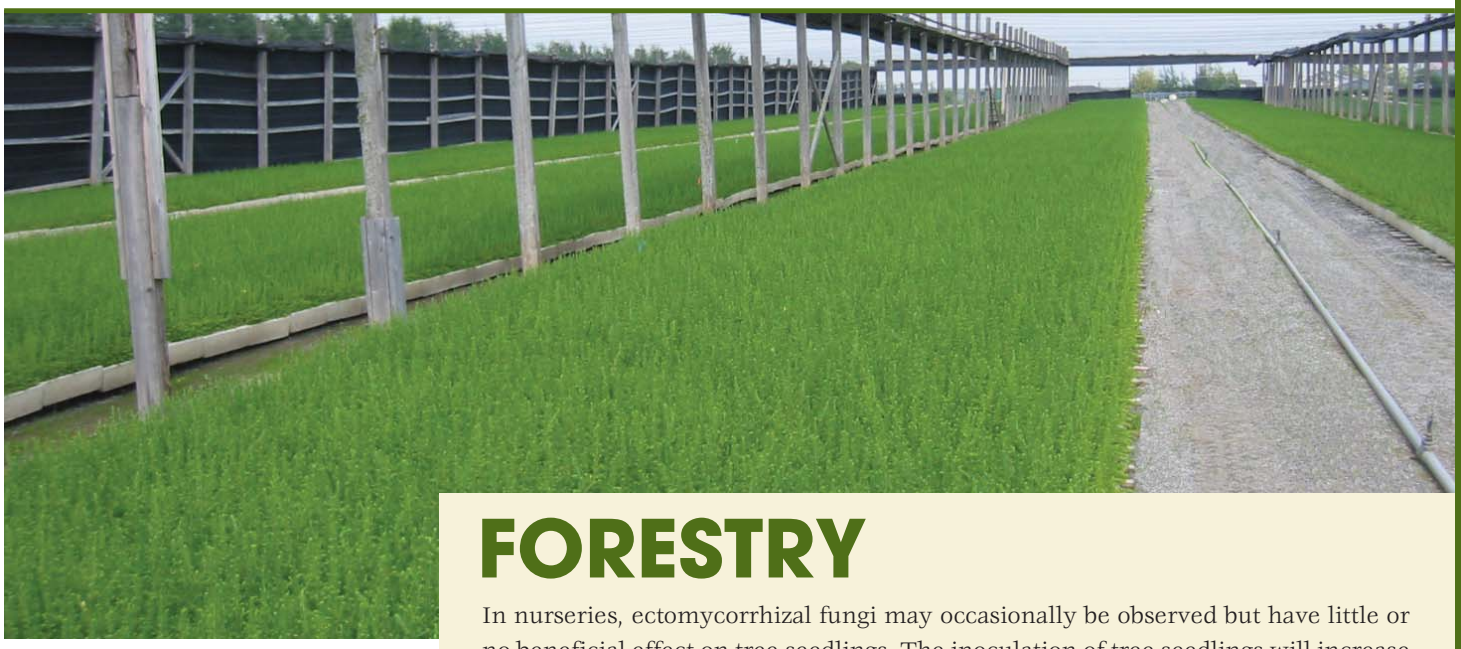


FORESTRY

In nurseries, ectomycorrhizal fungi may occasionally be observed but have little or no beneficial effect on tree seedlings. The inoculation of tree seedlings will increase tree tolerance to stressful conditions resulting in increased survival rates.

GREEN ASH

INVESTIGATOR

Michèle Bettez et al., Berthier Provincial Nursery, QC

OBJECTIVE

Evaluate growth improvement of green Ash grown with mycorrhizal inoculant.

METHODS

Green ash seeds were stratified with cold water for 10 weeks. After stratification treatment, the seeds were sown in peat substrate with mycorrhizal inoculant and a control consisting of a non-inoculated medium was used for growth comparison. Media pH was 6.0.

Forty-five cavity styroblock containers were used and four replicates were prepared for each treatment (mycorrhizal and non-mycorrhizal treatment). The experimental design was a randomised complete block. Every month, plant height was measured on all plants. Plants were harvested after 5 months of growth.

RESULTS

Results showed significant differences in the heights of controls and colonised plants throughout the growth period ($P = 0.01$) (Figure 1). Green ash grown with mycorrhizae had an average increase in stem height of 36% after two months of growth.

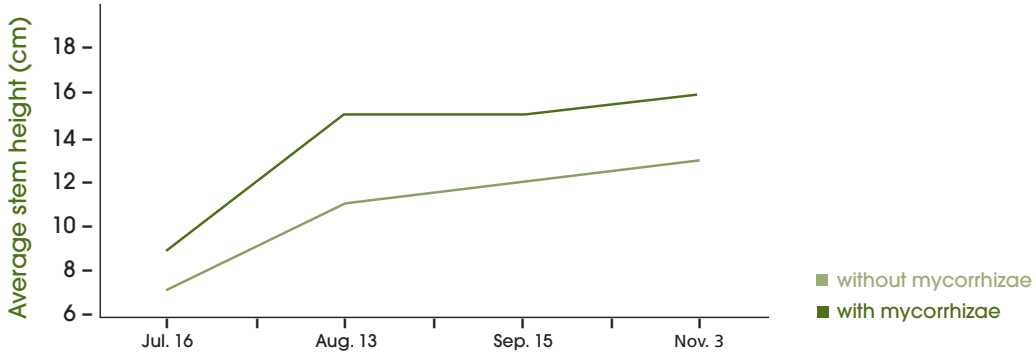


Figure 1

Effect of mycorrhizae on ash stem height for a growth period of thow months.

LEUCAENA

INVESTIGATOR

Marc Beland et al. Premier Tech Biotechnologies, 2005

OBJECTIVE

Evaluate benefits of mycorrhizal inoculation on Leucaena (*Leucaena leucocephala*) in a forestry nursery in Mexico.

METHODS

Mycorrhizal inoculation was done on germinated seedlings (3 weeks old) at Colima nursery in March 2004. Fungal inoculum of *Glomus intraradices* was added or not to 5 ml of water and applied with a custom hand sprayer individually to seedlings. Mycorrhizal inoculum was added according to the following recommendations:

Spores 1 = 75 spores per plant
Spores 2 = 150 spores per plant

There were 77 seedlings per tray and three trays per treatment. Ten plants per tray were harvested after 16 weeks; measurement of their height, collar diameter, fresh weight, aerial fresh/dry weight, root fresh/dry weight was recorded.

RESULTS

Leucaena leucocephala responded very well to endomycorrhizal inoculation. Growth increases were seen for all measured parameters (table 1). There was no difference between both levels of inoculum added. Increases for collar diameter (6%), height (18%), total fresh weight (24%), aerial fresh weight (24%), root fresh weight (25%) were recorded for mycorrhizal plants. Means for dry weights resulted in an slightly smaller increase for aerial dry weight (20% vs 24% fresh) and for root dry weight (14% vs 25%).

Picture 1
General appearance of *Leucaena leucocephala* exposed to various treatments.

Table 1
Leucaena leucocephala growth characteristics after 16 weeks post inoculation in the nursery.

Treatment	Avr collar diameter (mm)	Avr plant height (cm)	Avr fresh wt (g)	Avr fresh aerial wt (g)	Avr fresh root wt (g)	Avr dry aerial wt (g)	Avr dry root wt (g)
Control	5.13	65.43 a	14.42 a	7.88 a	6.54 a	3.33	1.66
Glomus intraradices (spores 1)	5.36	78.26 b	18.23 b	9.33 b	8.87 b	3.73	1.98
Glomus intraradices (spores 1)	5.47	76.64 b	17.76 b	9.96 b	7.81 a	4.12	1.86
		p<0.001	p<0.01	p<0.05	p<0.01		

For each parameter and treatment,values with different letters differ significantly

MICHOACAN PINE

INVESTIGATOR

Marc Beland et al. Premier Tech Biotechnologies, 2005

OBJECTIVE

Demonstrate the benefits of mycorrhizal inoculation on Michoacan Pines (*Pinus michoacána*) in a forestry nursery in Mexico.

METHODS

Mycorrhizal inoculation was done on germinated seedlings (10 weeks old) at Morelia nursery on March 2004. Fungal inoculum of *Pisolithus tinctorius* was added or not to 5 ml of water and applied with a custom hand sprayer individually to seedlings. Mycorrhizal inoculum was added according to the following recommendations:

Spores 1 = 1 million spores per plant
Spores 2 = 3 million spores per plant
Hyphae 1 = 50 propagules per plant
Hyphae 2 = 100 propagules per plant

There were 77 seedlings per tray and 4 trays per treatment. Eight individuals per tray were harvested after 16 weeks; height, collar diameter, fresh weight, aerial fresh/dry weight, root fresh/dry weight was measured.

RESULTS

Pinus michoacána responded very well to mycorrhizal inoculation with *Pisolithus tinctorius*. Significant increases in all growth parameters measured were observed between mycorrhizal and non-mycorrhizal seedlings (table 1). There was no significant difference between inoculum types. A significant effect of inoculum level was detected. Significant increases for pooled mycorrhizal treatments on collar diameter (20%), total fresh weight (26%), aerial fresh weight (24%), root fresh weight (33%), aerial dry weight (18%) and dry root weight (28%) resulted in plants of greater vigour.

Picture 1
General appearance of *Pinus Michoacána* exposed to various treatments.

Table 1
Pinus michoacána growth characteristics after 16 weeks post inoculation in the nursery.

Treatment	Avr collar diameter (mm)	Avr plant height (cm)	Avr fresh wt (g)	Avr fresh aerial wt (g)	Avr fresh root wt (g)	Avr dry aerial wt (g)	Avr dry root wt (g)
Control	4.96 a	10.29 a.b	14.26 a	10.30	3.96 a	2.30	0.61 a
Pisolithus tinctorius (spores 1)	5.94 b	11.76 b	17.40 a.b	12.41	5.00 a.b	2.39	0.67 a.b
Pisolithus tinctorius (spores 2)	5.89 b	11.68 b	18.61 b	12.53	6.04 b	2.85	0.91 b
Pisolithus tinctorius (hyphae 1)	3.14 b	11.34 a.b	18.00 a.b	13.18	4.81 a.b	2.75	0.78 a.b
Pisolithus tinctorius (hyphae 2)	5.92 b	9.36 a	18.28 b	13	5.28 a.b	2.84	0.76 a.b
	p<0.05	p<0.05	p<0.01	N.S.	p<0.05	N.S.	p<0.01

For each parameter and treatment,values with different letters differ significantly

BLACK MAPLE

INVESTIGATOR

John Klironomos et al. University of Guelph

OBJECTIVE

Evalute the influence of soil compaction on tree growth and survival with black maples inoculated with *Glomus intraradices*.

METHODS

A field experiment at the University of Guelph Arboretum, was initiated with the following four treatments: (1) soil compaction (bulk density ~ 2.5 mg m-3), (2) soil compaction + mycorrhizal inoculant + perlite carrier, (3) soil compaction + carrier control, (4) non-compaction control (bulk density ~ 1.8 Mg m-3). Each experimental unit consisted of a 1m^2 portion of soil, with each a five-year old, pot-grown, black maple sapling. There were ten repetitions per treatment for a total of 40 experimental units. Plants were assessed for mycorrhizal colonization prior to planting and were found roots to be colonized with less than 10%. To the inoculation treatments, commercial inoculum mycorrhizae was added at the recommended rates. The compaction treatment was initiated 2 weeks after the trees were planted and was repeated once a week for the following four weeks. Compaction was applied manually by a 140 lb person who treated the 1x1 m area around each tree by walking around them 5 times with small steps while the soil was moist.

RESULTS

After one growing season, the plants did not appear to grow any taller under the various treatments. However, compaction did negatively impact the number of leaf days in the saplings (Figure1.). Leaf-fall was initiated sooner in the compaction treatment, but this was reversed with the addition of mycorrhizal inoculant. By the end of the first growing season (1997), all saplings remained alive (Figure 2). But during the summers of 1998 and 1999, there were severe droughts in southern Ontario, and whereas all sapling survived the non-compaction treatment, only 1 untreated sapling survived the compaction treatment (Figure 2). The addition of mycorrhizal inoculant or of the perlite carrier increased survival under compaction, mycorrhizal was particularly effective (only one plant was lost). In the carrier treatment alone, less than half the plants survived. By the end of the experiment there was still some residual carrier effect however, minimal compared to the significant effect of inoculation in the compaction treatments.

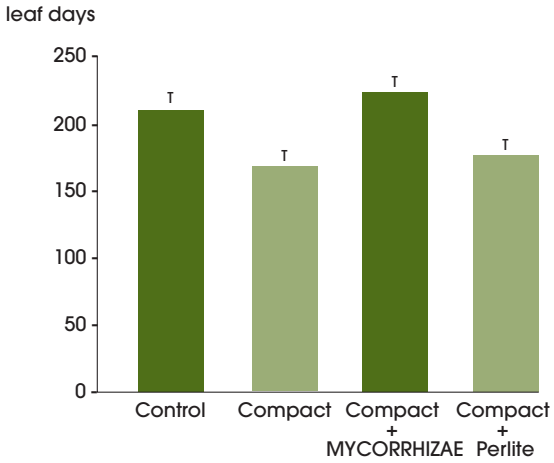


Figure 1

Number of days with leaves on first growing season

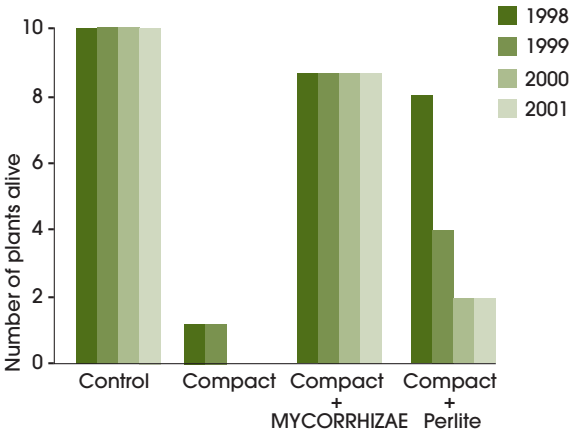


Figure 2

Tree survival

SMOOTH BARK MEXICAN PINE

INVESTIGATOR

Marc Beland et al. Premier Tech Biotechnologies, 2005

OBJECTIVE

Determine the benefits of mycorrhizal inoculation of Smooth Bark Mexican Pines (*Pinus pseudostrobus*) in a forestry nursery in Mexico.

METHODS

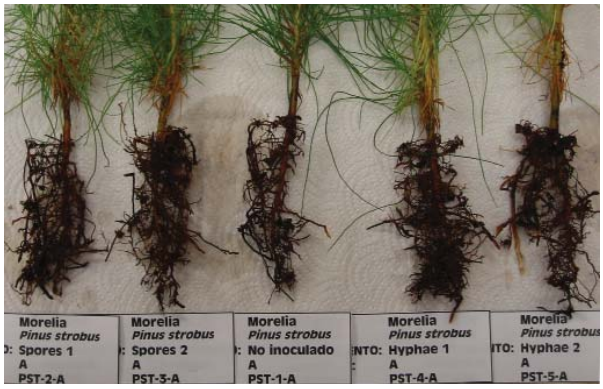
Mycorrhizal inoculation was done on germinated seedlings (10 weeks old) at Morelia nursery in March 2004. Fungal inoculum of *Pisolithus tinctorius* was added or not to 5 ml of water and applied with a custom hand sprayer individually to seedlings. Mycorrhizal inoculum was added according to the following recommendations:

Spores 1 = 1 million spores per plant
Spores 2 = 3 million spores per plant
Hyphae 1 = 50 propagules per plant
Hyphae 2 = 100 propagules per plant

There were 77 seedlings per tray and 4 trays per treatment. Eight individuals per tray were harvested after 16 weeks; their height, collar diameter, fresh weight, aerial fresh/dry weight, root fresh/dry weight was measured.

RESULTS

Pinus pseudostrobus responded very well to mycorrhizal inoculation with *Pisolithus tinctorius*. Significant increases in all growth parameters measured were observed between mycorrhizal and non-mycorrhizal seedlings (table 1). There were no significant differences between inoculum type and level of inoculum added. Significant increases for collar diameter (20%), height (19%), total fresh weight (33%), aerial fresh weight (30%), root fresh weight (40%), aerial dry weight (33%) and dry root weight (43%) resulted in plants of greater vigour.



Picture 1

General appearance of *Pinus pseudostrobus* exposed to various treatments.

Table 1

Pinus pseudostrobus growth characteristics after 16 weeks post inoculation in the nursery.

Treatment	Avr collar diameter (mm)	Avr plant height (cm)	Avr fresh wt (g)	Avr fresh aerial wt (g)	Avr fresh root wt (g)	Avr dry aerial wt (g)	Avr dry root wt (g)
Control	3.32 a	22.75 a	11.88 a	8.37 a	3.54 a	2.09 a	0.52 a
Pisolithus tinctorius (spores 1)	3.95 b	27.83 b	16.33 b	11.53 b	4.89 b	2.89 b	0.73 b
Pisolithus tinctorius (spores 2)	3.84 b	26.90 b	15.33 b	10.50 b	4.86 b	2.69 b	0.72 b
Pisolithus tinctorius (hyphae 1)	4.04 b	26.72 b	15.88 b	10.61 b	5.32 b	2.56 b	0.79 b
Pisolithus tinctorius (hyphae 2)	4.04 b	26.86 b	15.81 b	11.02 b	4.81 b	2.66 b	0.73 b
	p<0.05	p<0.05	p<0.05	p<0.05	p<0.05	p<0.05	p<0.05

For each parameter and treatment,values with different letters differ significantly

JACK PINE

INVESTIGATOR

D. H. Marx, et al., Forest Sci. 28 (2): 373-400, 1982.

OBJECTIVE

Compare growth after 14 weeks between mycorrhizal and non mycorrhizal jack pine (*Pinus banksiana*) seedlings.

METHODS

Ectomycorrhizal fungus *Pisolithus tinctorius* was grown in a vermiculite-peat moss-nutrient mix, then harvested and dried. The inoculum was mixed at a concentration of 12% (v/v) with a 3:2 volume ratio of peat moss and vermiculite rooting medium. Dolomitic limestone and supemonophosphate (1.6 kg/m^3) were also added. The containers used were Ferdinand Rootainers® (40 cc per cavity). Stratified seeds of jack pine were sown, covered lightly with sand, and watered twice daily. The low fertility treatment consisted of fertilizing seedlings twice a week with 12 ml per plant of 2 200 mg/l of a 20-20-20 solution and 540 mg/l of NH_4NO_3. There were four blocks per treatment and ten seedlings per block. The experiment lasted 14 weeks after germination.

RESULTS

Results show that with a low fertilization level, *Pisolithus tinctorius* had a significant effect on growth of jack pine.

Table 1

Effect of mycorrhizae on growth of jack pine seedlings, 14 weeks after germination.

Treatment	Height (cm)
with MYCORRHIZAE	8.3 b
without MYCORRIZAE	5.9 a

Values with different letters differ significantly at P = 0.05

MYKE® Pro

TURF and LANDSCAPE

Mycorrhizal inoculant for turf, sport fields, urban landscapes and land restoration, re-establishes beneficial micro-organisms to soil and enhances plant-soil dynamics. Intense growing practices, environmental pressures and removal of native top soil have resulted in significant reductions of the naturally occurring mycorrhizal fungi. Restoring these fungi back in soil is an essential step in the process of building healthy soil resulting in decreased fertilizer requirements, increased root development and more productive turf.

CREEPING BENTGRASS

INVESTIGATOR

S. Pelletier et al., Laval University, QC

OBJECTIVE

Asses the impact of mycorrhizae on the incidence of dollar spot disease *Sclerotinia homeocarpa* and the establishment of bentgrass (*Agrostis*) seedlings.

METHODS

For the bentgrass establishment trial, the soil was prepared as recommended by the USGA standars. Two different cultivars were studied, Cato and Providence were seeded with a density of 750 grams per 100 m^{-2}. Mycorrhizal inoculant was incorporated at a rate of 250 ml/m^2. Fertilizer applied was 6-3-6. For the dollar spot trial, the experimental green established and described previously was inoculated with the disease the following year.

RESULTS

There was no difference between the two cultivars as to their response to mycorrhizae. Figure 1 illustrates the establishment of the Bentgrass throughout the summer of 1998. Most monitoring dates show a significant difference between the experimental plots with and without mycorrhizal inoculant. Figure 2 shows how mycorrhizae significantly reduced the incidence of dollar spot after treating the experimental green with S. *homeocarpa*.

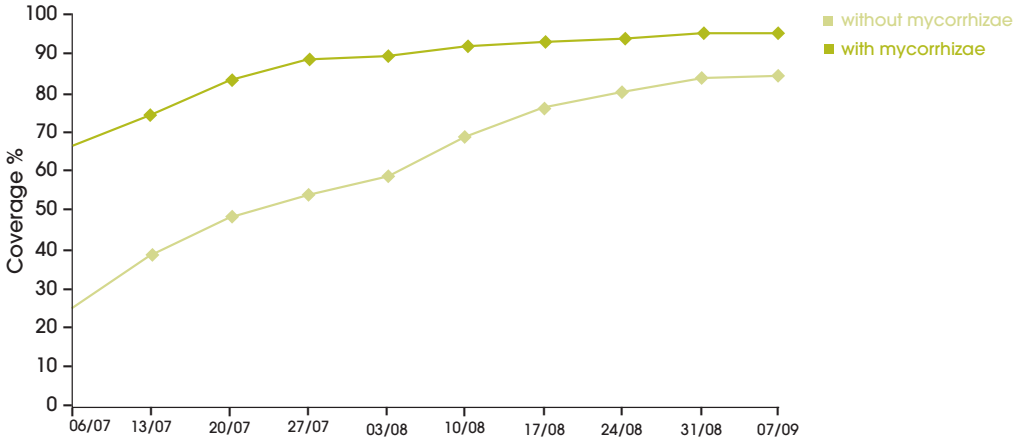


Figure 1

Bentgrass establishement thoughout the summer of 1998. Mycorrhizae increased the coverage of bentgrass on a newly constructed green by 100%.

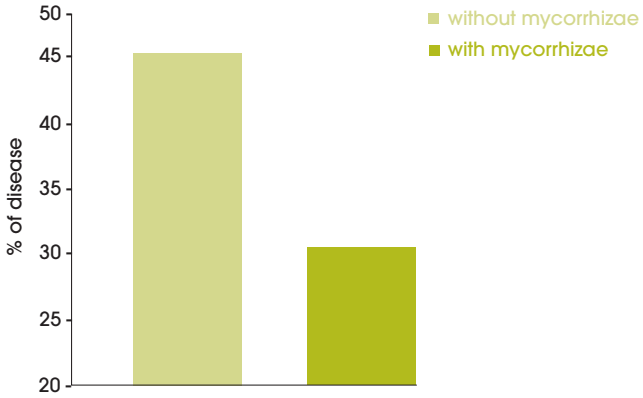


Figure 2

Percentage of Dollar spot on experimental green.

APPENDIX A

PESTICIDES

We have conducted tests with mycorrhizal fungi and various chemicals used when culturing different crops. These trials were meant to verify the compatibility of the mycorrhizal fungi present in our products with the chemicals commonly used in today's industry.

The products listed below are sorted in alphabetical order by commercial name of the chemicals.

The trials for testing pesticides effect on endomycorrhizal fungi were carried out on standard bio-assay plant, leek (*Allium porrum*). Leek is a trustable indicator plant of the viability of the mycorrhizal fungus exposed to various chemicals. Generally if the viability of the fungus is altered, the test plant will show indication of the pesticide compatibility.

Most insecticides and herbicides are compatible with the use of mycorrhizae.

PESTICIDE COMPATIBLE WITH **ENDOMYCORRHIZAL** FUNGI

FUNGICIDES	COMMERCIAL NAME	ACTIVE INGREDIENT
	Aliette	Fosethyl-aluminium
	Benlate	Bénomyl
	Bravo	Chlorothalonil
	Captan	Captane, Orthocide
	Carbamate	Fermate, Ferbam
	Carbendazim	Carboxin
	Dexon	
	Difolatan	Captafol
	Dithane	Mancozeb
	Easout	Thiophanate methyl
	Fuberidizole	
	Lesan	Fenaminosulf
	No-damp	Oxine benzoate
	Phaltan	Folpet
	Ridomil	Métalaxyle
	Rovral	Iprodione
	Subdue	Métalaxyle
	Sulfur	
	Terraclor-Quintozene	PCNB
	Thiophanate	
	Thiram	Thiram
	Truban	Etridiazol
	Vitavax	Carboxin

PESTICIDES COMPATIBLE WITH **ENDOMYCORRHIZAL** FUNGI

INSECTICIDES	COMMERCIAL NAME	ACTIVE INGREDIENT
	Agribrom (bromide-based)	Bromide based
	Ambush 25 wp	
	Ambush	Permetrin
	Cygon	Dimethoate
	Diazinon	
	Insecticidal soap	
	Kelthane	Dicofol
	Malathion	
	Morestan	Chinomethionat
	Metasystox	Oxydemeton-methyl
	Pentac	Dienochlor
	Pirimor	Pirimicarb
	Vendex	Fenbutatin-oxide
	Talstar-Attain	Bifenthrin
	Dursban	Chlorpyrifos
	Trumpet-Dycarb	Bendiocarb
	Enstar	Kinoprene
	Margoson	
	Mavrik	
	Orthene	
	Sevin	
	Avid	
	Citation	
	Marathon	
	Oxamyl	

PESTICIDES COMPATIBLE WITH **ECTOMYCORRHIZAL** FUNGI

FUNGICIDES	COMMERCIAL NAME	ACTIVE INGREDIENT
	Aliette	Fosethyl-aluminium
	Benlate	Bénomyl
	Captan	Captane, Orthocide
	Difolatan	Captafol
	Folpan	Folpet
	Ridomil	Métalaxyle
	Subdue	Métalaxyle
	Thiram	Thiram
	Carbamate	Fermate, Ferbam)
	Carbendazim	Carboxin
	Dexon	
	Fuberidizole	
	Thiophanate	

PESTICIDES TO AVOID USE WITH **ECTOMYCORRHIZAL** FUNGI

FUNGICIDES	COMMERCIAL NAME	ACTIVE INGREDIENT
	Banrot	
	Chlorothalonil	Daconil 2787, Bravo
	Macozeb	Ditane
	PCNB	Terraclor, Tri-PCNB
	Triadimefon	Bayleton
	Zineb	Ziram, Zerlate

APPENDIX B

HOST PLANTS AND FUNGUS COMPATIBILITY

Mycorrhiza are found naturally with most living plant species found in forests and other natural habitats. As shown in the introduction, there are certain plant families that do not become naturally colonized by the mycorrhizal fungi. As pointed out, certain disturbed area no longer have efficient mycorrhiza. In these soils, the addition of mycorrhiza at planting will greatly improve the survival and growth of the plants.

The mycorrhizal fungi found in our MYKE® product line are represented by 2 major types of mycorrhiza. The endomycorrhizal and the ectomycorrhizal type. Other types of mycorrhiza do occur naturally in certain specific type of soils, such as the soils of bogs where rhododendrons naturally occur. A specific type of endomycorrhiza for ericacea plants lives in these soils.

The same for orchids, very specific types of mycorrhiza will colonize this group of plants.

The following table was designed to provide a clearer picture of the type of mycorrhiza associated to the specific type of plant.

LEGEND:

ENDO:	Endomycorrhizal fungus avaible in the MYKE® PRO PS3, GS2, AG1
ECTO:	Ectomycorrhizal fungus avaible in the MYKE® PRO AN1, PN3 and LF3
ERICOID:	Endomycorrhizal fungus specific to the Ericaceae family (not available)
NO:	No known mycorrhizal fungus can colonize this plant

LATIN NAME	FAMILY	COMMON NAME	MYCORHRIZAL TYPE
Abies	Pinaceae	Fir	Ecto
Acer negundo	ceraceae	Ash-leaved Maple, Box Elder	Endo
Acer rubrum	Aceraceae	Red Maple	Endo
Acer saccharinum	Aceraceae	Silver Maple	Endo
Acer saccharum	Aceraceae	Sugar Maple	Endo
Achillea	Asteraceae	Yarrow	Endo
Aconitum	Ranunculaceae	Aconite, Monk s' hood	Endo
Actinidia	Actinidiadeae	Chinese Gooseberry	Endo
Aesculus glabra	Hippocastanaceae	Horse Chestnut, Buckeye	Endo
Ageratum	Asteraceae	Flossflower	Endo
Alcea rosea	Malvaceae	Hollyhock	Endo
Allium cepa	Liliaceae	Onion	Endo
Allium porrum	Liliaceae	Leek	Endo
Allium sativum	Liliaceae	Garlic	Endo
Allium schoenoprasum	Liliaceae	Chives	Endo
Alyssum	Bracicaceae	Madwort	No
Amaranthus	Amaranthaceaeh	Amaranth	Endo
Amelanchier canadensis	Rosaceae	Service berry, Shadbush	Endo
Anaphalis	Asteraceae	Everlasting	Endo
Androsace	Primulaceae	Rock Jasmine	Endo
Anethum graveolens	Apiaceae	Dill	Endo
Anthriscus cerefolium	Apiaceae	Chervil	Endo
Antirrhinum	Scrophulariaceae	Snapdragon	Endo
Apium graveolens	Apiaceae	Celery	Endo
Aquilegia	Ranunculaceae	Columbine	Endo
Arabis	Brassicaceae	Rorck Cress	No

LATIN NAME	FAMILY	COMMON NAME	MYCORHRIZAL TYPE
Arctostaphylos	*Ericaceae*	*Bearberry, Manzanita*	*Ericoid*
Arctostaphylos	*Ericaceae*		*Ericoid*
Armeria maritima	*Plumbaginaceae*	*Thrift, Sea Pik*	*Endo*
Aronia (arbutigolia)	*Rosaceae*	*Chokeberry*	*Endo*
Artemisia absinthium	*Asteraceae*	*Absinthe, Wormwood*	*Endo*
Artemisia dracunculus	*Asteraceae*	*Tarragon*	*Endo*
Asparagus officinalis	*Liliaceae*	*Asparagus*	*Endo*
Aster	*Asteraceae*	*Aster, Starwort*	*Endo*
Astilbe	*Saxifragaceae*	*Astilbe*	*Endo*
Aubrieta	*Brassicace*	*Aubrieta, Rockcress*	*No*
Baptisia	*Fabceae*	*False Indigo*	*Endo*
Begonia	*Begoniaceae*	*Begonia*	*Endo*
Bellis	*Asteraceae*	*Daisy, English Daisy*	*Endo*
Bergenia	*Saxifragaceae*	*Bergenia*	*Endo*
Beta vulgaris	*Chenopodiaceae*	*Beet*	*No*
Beta vulgaris cicla	*Chenopodiaceae*	*Swiss chard*	*No*
Betula	*Betulaceae*	*Birch*	*Ecto*
Borago officinalis	*Boraginaceae*	*Borage*	*Endo*
Brassica	*Brassicaceae*	*Cole, Mustard*	*No*
Buxus	*Buxaceae*	*Boxwood*	*Endo*
Callistephus	*Asteraceae*	*Callistephus, China Aster*	*Endo*
Calluna	*Ericaceae*	*Heather*	*Ericoid*
Calluna	*Ericaceae*	*Heather*	*Ericoid*
Campanula	*Campanulaceae*	*Bellflower*	*Endo*
Capsicum annuum	*Solanaceae*	*Pepper*	*Endo*
Caragana arborescens	*Leguminosae*	*Pea Tree, Pea Shrub*	*Endo*
Carum carvi	*Apiaceae*	*Caraway*	*Endo*
Celosia	*Amaranthaceae*	*Woolflower*	*Endo*
Celtis occidentalis	*Ulmaceae*	*Nettle Tree*	*Endo*
Cerastium	*Caryophyllaceae*	*Mouse-Car, Chick Weed*	*No*
Chamaecyparis	*Cupressaceae*	*False Cypress*	*Endo*
Chamaedaphne	*Ericaceae*	*Leatherleaf*	*Ericoid*
Chamaedaphne	*Ericacea*		*Ericoid*
Chrysanthemum	*Asteraceae*	*Chrysanthemum, Pyrethrum*	*Endo*
Cichorium intybus	*Asteraceae*	*Chicory*	*Endo*
Citrullus vulgaris	*Cucurbitaceae*	*Watermelon*	*Endo*
Citrus	*Rutaceae*	*Citrus Fruit Rootstock*	*Endo*
Clarkia	*Onagraceae*	*Farewell –to Spring, Godetia*	*Endo*
Cleome	*Capparidaceae*	*Spider Plant*	*Endo*
Clethra alnifolia	*Clethraceae*	*Sweet Pepperbush*	*Endo*
Coleus	*Lamiaceae*	*Flame Nettle*	*Endo*
Coreopsis	*Asteraceae*	*Thickseed, Coreopsis*	*Endo*
Coriandrum sativum	*Apiaceae*	*Coriander*	*Endo*
Cornus stolonifera	*Cornaceae*	*Cornel Sericea*	*Endo*
Corylus	*Betulaceae*	*Hazelnut*	*Ecto*
Cosmos	*Asteraceae*	*Cosmos*	*Endo*
Cotoneaster	*Rosaceae*	*Cotoneaster*	*Endo*
Cucumis melo	*Cucurbitaceae*	*Melon*	*Endo*
Cucumis sativus	*Cucurbitaceae*	*Cucumber*	*Endo*
Cucurbita maxima	*Cucurbitaceae*	*Squash*	*Endo*

LATIN NAME	FAMILY	COMMON NAME	MYCORHRIZAL TYPE
Cucurbita pepo	*Cucurbitaceae*	*Pumpkin*	*Endo*
Cumimum cynimum	*Apiaceae*	*Cumin*	*Endo*
Cynara cardunculus	*Asteraceae*	*Cardoon*	*Endo*
Cynara scolymus	*Asteraceae*	*Artichoke*	*Endo*
Datura	*Solanaceae*	*Thorn Apple*	*Endo*
Daucus carota	*Apiaceae*	*Carrot*	*Endo*
Delphinium	*Ranunculaceae*	*Larkspur*	*Endo*
Dianthus	*Caryophyllaceae*	*Dianthus, Carnation*	*No*
Digitalis	*Scrophulariaceae*	*Foxglove*	*Endo*
EchinaceaAsteraceae	*Purple*	*Coneflower*	*Endo*
Echinops	*Asteraceae*	*Globe Thistle*	*Endo*
Elaeagnus angustifolia	*Elaeagnadeae*	*Wild Olive, Oleaster*	*Endo*
Elaeagnus commutata	*Elaeagnadeae*	*Silverberry*	*Endo*
Erica	*Ericaceae*	*Heath*	*Ericoid*
Erica	*Ericaceae*	*Heath*	*Ericoid*
Erigeron	*Asteraceae*	*Fleabane*	*Endo*
Eryngium	*Apiaceae*	*Sea Holly*	*Endo*
Eschscholzia	*Papaveraceae*	*California Poppy*	*Endo*
Euonymus	*Celastradeae*	*Spindle Tree*	*Endo*
Euphorbia	*Euphorbiaceae*	*Spurge*	*Endo*
Eustoma	*Gentianaceae*	*Eustoma, Prairie Gentian*	*Endo*
Fagus	*Fagaceae*	*Beech*	*Ecto*
Foeniculum vulgare	*Apiaceae*	*Fennel*	*Endo*
Fragaria	*Rosaceae*	*Strawberry*	*Endo*
Fraxinus americana	*Oleaceae*	*White Ash*	*Endo*
Fraxinus pensylvanica	*Oleaceae*	*Red Ash, Green Ash*	*Endo*
Fuchsia	*Onagraceae*	*Lady's Eardrops, Fuchisa*	*Endo*
Gaillardia	*Asteraceae*	*Blanket Flower*	*Endo*
Gazania	*Asteraceae*	*Gazania*	*Endo*
Geranium	*Geraniaceae*	*Perennial Geranium*	*Endo*
Geum	*Rosaceae*	*Avens*	*Endo*
Ginkgo biloba	*Ginkgoceae*	*Maidenhair Tree*	*Endo*
Gleditsia	*Leguminosae*	*Honey Locust*	*Endo*
Gymnocladus	*Leguminosae*	*Kentucky Coffee Tree,*	*Endo*
Gypsophila	*Caryophyllaceae*	*Gypsophila, Baby's Breath*	*No*
Helenium	*Asteraceae*	*Sneezeweed*	*Endo*
Helianthus	*Asteraceae*	*Sunflower*	*Endo*
Heliopsis	*Asteraceae*	*Ox Eye*	*Endo*
Heliotropium	*Boraginaceae*	*Heliotrope*	*Endo*
Hesperis	*Brassicaceae*	*Rocket*	*No*
Heuchera	*Saxifragaceae*	*Alumroot*	*Endo*
Hibiscus	*Malvaceae*	*Mallow*	*Endo*
Hibiscus esculentus	*Malvaceae*	*Okra*	*Endo*
Hippophea rhamnoïdes	*Elaeagnaceae*	*Sea Buckthorn*	*Endo*
Hosta	*Liliaceae*	*Hosta*	*Endo*
Hydrangea paniculata	*Saxifragaceae*	*Hydrangea*	*Endo*
Hypericum	*Guttiferae*	*St. Johnswort*	*Endo*
Hypoestes	*Acanthaceae*	*Hypoeste, Polea Dot Plant*	*Endo*
Hyssopus officinalis	*Lamiaceae*	*Hyssop*	*Endo*

LATIN NAME	FAMILY	COMMON NAME	MYCORHRIZAL TYPE
Iberis	*Brassicaceae*	*Candytuft*	*No*
Ilex	*Aquifoliaceae*	*Holly*	*Endo*
Impatiens	*Balsaminaceae*	*Balsam*	*Endo*
Incarvillea	*Clusiiaceae*	*Incarvillea, Hardygloxinia*	*Endo*
Juglans cinera	*Juglandaceae*	*Butternut, White Walnut*	*Endo*
Juglans nigra	*Juglandaceae*	*Black Walnut*	*Endo*
Juniperus	*Cupressaceae*	*Juniper*	*Endo*
Kalmia	*Ericaceae*	*Mountain Laurel,*	*Ericoid*
Kalmia	*Ericaceae*	*Mountain Laurel*	*Ericoid*
Kalmiopsis	*Ericaceae*	*Kalmiopsis*	*Ericoid*
Kniphofia	*Liliaceae*	*Torch Lily, Red-Hot-Poker,*	*Endo*
Kochia	*Chenopodiaceae*	*Kochia*	*No*
Lactuca	*Asteraceaee*	*Lettuce*	*Endo*
Lathyrus	*Fabaceae*	*Wild Pea, Sweet Pea*	*Endo*
Lavandula	*Lamiaceae*	*Lavender*	*Endo*
Lavatera	*Malvaceae*	*Tree Mallow*	*Endo*
Ledum	*Ericaceae*	*Labrador Tea*	*Ericoid*
Leontopodium	*Asteraceae*	*Edelweiss*	*Endo*
Levisticum officinalis	*Apiaceae*	*Lovage*	*Endo*
Liatris	*Asteraceae*	*Blazing-Star*	*Endo*
Limonium	*Plumbaginaceae*	*Statice, See Lavender*	*Endo*
Linum	*Linaceae*	*Flax*	*Endo*
Lobelia	*Campanulaceae*	*Lobelia, Cardinal Flower*	*Endo*
Lobularia	*Brassicaceae*	*Lobularia, Sweet Alyssum*	*No*
Lunaria	*Brassicaceae*	*Money Plant, Honesty*	*No*
Lupinus	*Fabaceae*	*Lupine*	*No*
Lychnis	*Caryophyllaceae*	*Campion, Catch Fly*	*No*
Lycopersicon exculentum	*Solanaceae*	*Tomato*	*Endo*
Lysimachia	*Primulaceae*	*Loosestrife*	*Endo*
Lythrum	*Lythraceae*	*Purple Loosestrife*	*Endo*
Magnolia	*Magnoliaceae*	*Magnolia*	*Endo*
Malus	*Rosaceae*	*Apple Tree*	*Endo*
Malva	*Malvaceae*	*Mallow, Musk Mallow*	*Endo*
Matricaria	*Asteraceae*	*Matricaria, Camomile*	*Endo*
Matricaria recutica	*Asteraceae*	*Chamomile*	*Endo*
Matthiola	*Brassicaceae*	*Matthiola, Stock*	*No*
Melissa officinalis	*Lamiaceaee*	*Lemon Balm*	*Endo*
Mentha	*Lamiaceae*	*Mint*	*Endo*
Mimulus	*Scrophulariaceae*	*Monkey Flower*	*Endo*
Monarda	*Lamiaceae*	*Wild Bergamot, Horsemint*	*Endo*
Myosotis	*Boraginaceae*	*Forget-Me-Not, Scorpion*	*Endo*
Nemesia	*Scrophulariaceae*	*Nemesia*	*Endo*
Nepeta	*Lamiaceae*	*Catmint*	*Endo*
Nicotiana	*Solanaceae*	*Flowering Tobacco*	*Endo*
Nirembergia	*Solanaceae*	*Cup Flower*	*Endo*
Nolana	*Nolanaceae*	*Nolana*	*Endo*
Ocimum basilicum	*Lamiaceae*	*Basil*	*Endo*
Oenothera	*Onagraceae*	*Evening Primrose, Sundrops*	*Endo*
Origanum marjorana	*Lamiaceae*	*Marjoram*	*Endo*
Origanum vulgare	*Lamiaceae*	*Oregano*	*Endo*

LATIN NAME	FAMILY	COMMON NAME	MYCORHRIZAL TYPE
Papaver	*Papaveraceae*	*Poppy*	*Endo*
Parthenocissus quinquefolia	*Vitaceae*	*Woodbine*	*Endo*
Pastinaca sativa	*Apiaceae*	*Parsnip*	*Endo*
Pelargonium	*Geraniaeceae*	*Geranium, Storksbill*	*Endo*
Penstemon	*Scrophulariaceae*	*Bearded Tongue*	*Endo*
Petroselinum cripsum	*Aspiacea*	*Parsley*	*Endo*
Petunia X Hybrida	*Solanaceae*	*Petunia*	*Endo*
Phaseolus vulgaris	*Fabaceae*	*Bean*	*Endo*
Phlox	*Polemoniaceae*	*Phlox*	*Endo*
Physalis	*Solanaceae*	*Ground Cherry,*	*Endo*
Physocarpus	*Rosaceae*	*Ninebark*	*Endo*
Physostegia	*Lamiaceae*	*False Dragonhead,*	*Endo*
Picea	*Pinaceae*	*Spruce*	*Ecto*
Pimpinella anisum	*Aspiaceae*	*Anise*	*Endo*
Pinus	*Pinaceae*	*Pine*	*Ecto*
Pisum sativum	*Fabaceae*	*Pea*	*Endo*
Platycodon	*Campanulaceae*	*Balloon Flower*	*Endo*
Populus	*Salicaceae*	*Poplar*	*Ecto*
Portulaca	*Portulacaceae*	*Purslane*	*Endo*
Potentilla	*Rosaceae*	*Cinquefoil, Five-Fingers*	*Endo*
Poterium sanguisorba	*Rosaceae*	*Burnet*	*Endo*
Primula	*Primulaceae*	*Primrose*	*Endo*
Prunus	*Rosaceae*	*Plum Tree*	*Endo*
Pulsatilla	*Ranunculaceae*	*Pasque Flower*	*Endo*
Pyrethrum	*Compositae*	*Pyrethrum*	*Endo*
Quercus	*Fagaceae*	*Oak*	*Ecto*
Raphanus sativus	*Brassicaceae*	*Radish*	*No*
Rheum rhaponticum	*Polygonaceae*	*Rhubarb*	*Endo*
Rhododendron	*Ericaceae*	*Rododendron, Azalea*	*Ericoid*
Rhododendron	*Ericaceae*		*Ericoid*
Rhus	*Anacardiadeae*	*Sumac*	*Endo*
Ribes nigrum	*Saxifragaceae*	*Black Current*	*Endo*
Ricinus	*Euphorbiaceae*	*Ricinus, Castor Oil Plant*	*Endo*
Robinia	*Leguminosae*	*Locust*	*Endo*
Rosa	*Rosaceae*	*Rose, Brier*	*Endo*
Rosmarinus officinalis	*Lamiaceae*	*Rosemary*	*Endo*
Rubus	*Rosaceae*	*Bramble*	*Endo*
Rubus idaeus	*Rosaceae*	*Raspberry*	*Endo*
Rudbeckia	*Asteraceae*	*Coneflower*	*Endo*
Rumex acetosa	*Polygonaceae*	*Sorrel*	*Endo*
Ruta graveolens	*Lamiaceae*	*Rue*	*Endo*
Salpiglossis	*Solanaceae*	*Salpiglossis, Painted Tongue*	*Endo*
Salvia	*Lamiaceae*	*Sage*	*Endo*
Sambucus	*Caprifoliaceae*	*Elder*	*Endo*
Sanvitalia	*Asteraceae*	*Sanvitalia*	*Endo*
Saponaria	*Caryophyllaceae*	*Soapwort*	*No*
Satureja hortensis	*Lamiaceae*	*Summer Savory*	*Endo*
Scorzonera hispanica	*Asteraceae*	*Salsifiy*	*Endo*
Sedum	*Crassulaceae*	*Stonecrop, Orpine*	*No*

LATIN NAME	FAMILY	COMMON NAME	MYCORHRIZAL TYPE
Sempervivum	*Crassulaceae*	*Houseleek, Live-Forever*	*No*
Senecio	*Asteraceae*	*Groundsel, Dusty Miller*	*Endo*
Shepherdia argentea	*Elaeagnadeae*	*Buffalo Berry*	*Endo*
Solanum melongena	*Solanaceae*	*Eggplant*	*Endo*
Sorbaria	*Rosaceae*	*False Spirea*	*Endo*
Sorbus	*Rosaceae*	*Mountain Ash*	*Endo*
Spinacia oleracea	*Chenopodiaceae*	*Spinach*	*No*
Spirea	*Rosaceae*	*Spirea*	*Endo*
Symphoricarpos albus	*Caprifoliaceae*	*Snowberry*	*Endo*
Syringa	*Oleaceae*	*Lilac*	*Endo*
Tagetes	*Asteraceae*	*Marigold*	*Endo*
Tanacetum vulgare	*Asteraceae*	*Tansy*	*Endo*
Taxus	*Taxaceae*	*Yew*	*Endo*
Thalictrum	*Ranunculaceae*	*Meadow Rue*	*Endo*
Thuja	*Cupressaceae*	*Cedar*	*Endo*
Thymus	*Lamiaceae*	*Thyme*	*Endo*
Tithonia	*Asteraceae*	*Mexican Sunflower*	*Endo*
Tropaeolum	*Tropaeolaceae*	*Nasturtium*	*Endo*
Ulmus	*Ulmaceae*	*Elm*	*Ecto*
Vaccinium	*Ericaceae*	*Blueberry*	*Ericoid*
Verbascum	*Scrophulariaceae*	*Mullein*	*Endo*
Verbena	*Verbenaceae*	*Vervain*	*Endo*
Veronica	*Scrophulariaceae*	*Speedwell*	*Endo*
Viburnum	*Caprifoliaceae*	*Arrowwood*	*Endo*
Vinca	*Apocynaceae*	*Periwinkle*	*Endo*
Viola	*Violaceae*	*Violet*	*Endo*
Vitis	*Vitaceae*	*Grape*	*Endo*
Weigela	*Caprifoliaceae*	*Weigela*	*Endo*
Weigela	*Caprifoliaceae*	*Weigela*	*Endo*
Zea mays	*Poaceae*	*Corn*	*Endo*
Zinnia	*Asteraceae*	*Zinnia*	*Endo*

COPORATE INFORMATION

For the past 20 years, Premier Tech Biotechnologies has been working on important research and development projects resulting in leading-edge technology in the production of mycorrizal fungi. Supported by a team of specialists, Premier Tech Biotechnologies has developed, on an industrial scale, ecological products containing mycorrhizal fungi and other beneficial organisms that improve plant growth without harming the environment or humans.

TECHNICAL SUPPORT

Premier Tech Biotechnologies offers technical support; either for in-store training, conferences or visits to garden centres. Our team is there to answer all your needs. Don't hesitate to contact us.

CUSTOMER SERVICE

Our customer service agents are specially trained to answer your questions or comments concerning product recommendations, growth benefits and how our products work. Our customer service team is available Mondays thru Fridays, from 8:00 a.m. to 5:00 p.m. eastern time. It is also possible to leave us a detailed message on our voice mail, or by email at info@usemyke.com; we will reply to your message the following day without delay.



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