A simple method for making your own mycorrhizal inoculum

This is a method of inoculating your plants with beneficial fungi. You can make your own from your own local soil. The soil that you make will be rich in beneficial fungi. This will be the 'inoculum'. It takes about an hour or less to set up and is very simple to maintain.

Page Content…

Introduction

What are mycorrhiza?

Mycorrhizal fungi are a group of soil fungi that infect the roots of most plants. The fungi is not a pest or parasite as it supplies the plant with nutrients like phosphorus, copper and zinc, as well as increasing water availability. The plant supports the fungus with carbon in the form of sugars. This symbiotic relationship does not affect the plants, as they produce excess carbon. In fact, lack of water and nutrients is more often the limiting factor to plants' growth and establishment. Mycorrhizal fungi are found in most environments, although their importance is greater in more extreme environments, where nutrients and water may be limited. There are very few plants that do not form mycorrhizal associations at all, although most can grow without it. In plants that have been infected by mycorrhizal fungi, the fungus is actually the chief method of nutrient uptake, not the roots.

There are several types of mycorrhiza, the type that we are interested in are by far the most common and are called arbuscular mycorrhiza (AM). This type of mycorrhiza is invisible to the naked eye but forms a fine mesh through the soil. They enter the cells of the roots where they form branched arbuscles within these cells, this is where the exchange of nutrients and carbon occurs.

How do you know if a plant species can be a host to this type of fungus?

The vast majority of plants do form AM. This includes the majority of domestic and wild plants. However some species do not form this association, these include pines, firs, spruce and oaks. It would be impossible to list all the species and their mycorrhizal associations, so if you are in any doubt then contact us and we can confirm if this species will benefit from the inoculation method.

Results that you can expect

The most notable improvement should be an increase in survival rate. It has been shown that mycorrhizal plants cope better with stresses such as dry conditions and disease than non-mycorrhizal plants. Depending on your conditions and the species that you are using you may also notice an increase in growth. This is due to the plant accessing more phosphorus from the soil (this varies from just a few percent to double the normal growth). There are other benefits that mycorrhiza can bring to the soil. Its fine structure helps stabilise the soil structure, slowing both sheet and subsurface erosion. Under the soil, invisible from above, a network of fungal hyphae will start to spread from your plant, gradually colonizing other plants and in effect starting to rebuild a healthy ecosystem. The underground structure is the key part of restoring the ecosystem. The plants

then act as fertility islands, with increased organic matter, better soil nutrient levels and with increased nutrient cycling.

Get involved!

The results so far have been very positive showing faster growth and better survival in the most arid areas of Spain and Tanzania where we have been trying this method. However, we are still at the trial stage and we want to know how it works in different locations, climate, soil type, and with a variety of species.

If you are interested in producing your own inoculum for your own use and/or running some trials we have constructed this methods page, with a step-by-step guide to setting up your own experiment using a mixed mycorrhizal inoculum made from your own soil. This also instructs you on how to set up your own trial with different target species, be it trees or crops, seeds, seedlings or established plants.

METHOD OF MAKING A MYCORRHIZAL INOCULUM

Mycorrhizal inoculum can be produced either in pots or in a 'trap-trough'. The method is virtually the same for both.

If you decide to try this method, we would like you to tell us how you get on and what sort of results you get. We want to know how useful you found it, if the rewards were worth the effort, etc.

The first step would be to fill out a trial proposal form. You can also see a sample completed form for our trial in Tanzania. Once completed, this will give us vital information about the conditions in which your trial will be carried out, including climate and soil type, and the species that you will be attempting to grow in the trap pot. It will also enable us to make sure the proposed trial is viable.

Once your trial is established we would like you to keep us informed of its progress.

We are always contactable and able to give advice and support on the phone, by post or by email.

We can give you information and support on the following:

1. Where to collect your starter soil
2. How to set up a trap-trough to make your own inoculum
3. How to maintain your trap-trough
4. How to harvest the inoculum
5. How to use the inoculum
6. How to set up a trial
7. How to record the progress of your inoculated and uninoculated plants

Before you start you will need….

- An area to dig a trench or set up some pots
- Plastic sacks or other waterproof material sheeting/plastic pots (5 litres or larger)
- Spade or other digging implement
- Seeds
- Water

1. Collecting your 'Starter Soil'

Materials needed: spade, sacks and/or wheelbarrow to move soil.

Where? Around 80% of vegetation forms mycorrhizal associations. The infected plant roots and the spores and hyphae of the beneficial fungi are in the soil and can colonize new plants. You can be pretty sure of getting a good starter soil from any undisturbed area containing native vegetation including most grown trees, woody shrubs and perennial grasses.

The best place to collect your starter soil is from under local native vegetation that is growing well in an area that has not recently been cultivated. It is good if you can collect some of the soil from under the same species as that on which you plan to use the mycorrhizal inoculum (i.e. your tree, shrub or crop species).

Method: Clear away about 0.5m^2 of the vegetation underneath your target plant. Dig down to a depth of about 25cm collecting the soil and as many fine roots as possible. It is better, but not essential, to collect from under several different trees and shrubs. With stony soil sieve it to get rid of large stones.

2. Multiplying the mycorrhiza

To multiply the mycorrhiza from your starter soil we use a 'trap-pot'. This method grows mycorrhizal dependent annuals in the collected soil. These plants, often called "bait plants", will become infected with the mycorrhizal fungus causing the fungal population to multiply. Often two bait plant species are grown together to enhance different mycorrhizal fungal species multiplication. One of these will be a species of graminacae or alium, and the second will be a species of legume. Examples of these species are shown in the table below. Combining maize and beans, for example, is a good choice as they grow well together. It depends, however, on what you know to grow well in your area and on what you have available.

Select species 1		Select species 2
Graminacae **species**	***Allium*** **species**	***Leguminacae*** **species**
Maize	Leeks	Alfalfa
Millet	Onions	Beans
Sorghum		Clover
Wheat		Peas
Oats		Lentils

Materials needed: spade, plastic sacks/pots (5 litres or larger), seeds of your two selected species, water.

Where? The best place is in a site that will not be needed for at least three months and where you can keep an eye on it. It will need regular watering, adequate light and protection from herbivores.

Method: Take your starter soil to the site you have chosen and then either fill one or several plastic pots/basins (depending on how much inoculum you need). Alternatively, a trench can be dug into the ground and lined with the plastic sacks or other material available. This is what we call a 'trap-trough'. The pit should be dug about 100cm x 50cm to a depth of 50cm and then lined with the

plastic sacks. Plastic sheeting, bin liners or sugar sacks will be fine. Perforate the plastic to allow for drainage. Make sure that it covers the whole basin with an overlap. Place stones on the overlap and fill the trough with the soil. Soak the seeds of your two chosen species overnight. Plant them closer than normal, alternating the species.

Note: the soil that you dig out of the trench can be used to fill in the holes where you extracted soil from under the local vegetation.

How much inoculum do you want to make? This depends on what size container you will be planting in, but estimate about 1/6 of each pot to be filled with the inoculum. If using on crops see 'inoculating crops' below.

3. Maintaining your trap-pots or trough

Once you have set up your trap-pot or trough you can more or less forget about it. Just keep it regularly watered. In this time the roots of the bait plants will be developing and forming the association with the mycorrhiza. Depending on the season you might need to shade it or protect it from frost. If growing trap-pots then they can be moved into a more sheltered area.

4. Three months later…

Ten days before you are ready to use the inoculum, the bait plants should be cut at the base of their stem and watering should be stopped. This kills the plant, and tricks the fungus into producing reproductive spores. Then, after the ten days, the inoculum is prepared by pulling up the roots of the bait plants which should be chopped into roughly 1cm pieces and then mixed back into the soil from the trap-pot or trough. This mixture of roots and soil is the inoculum.

5. Using the inoculum

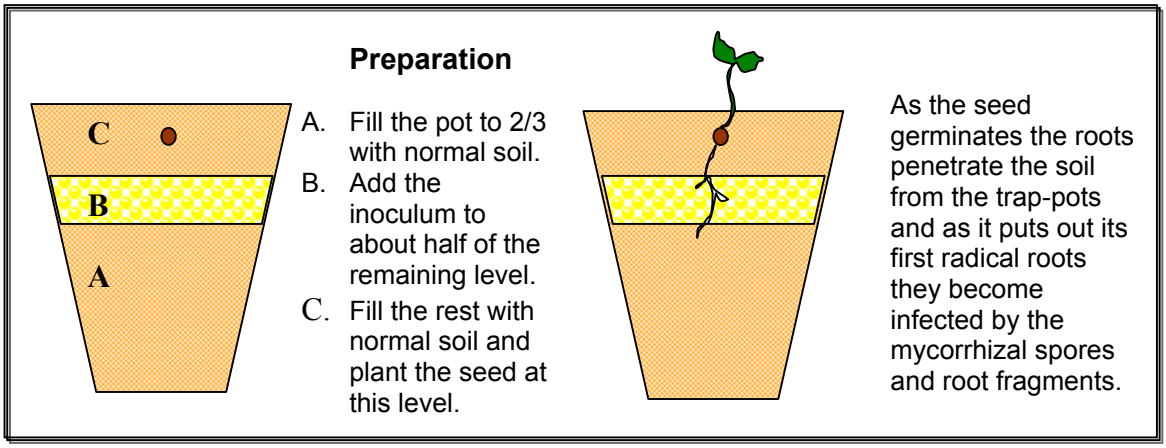
The inoculum can be used on a wide range of different trees, shrubs, crops and garden plants. In all cases the plants should be given the same care as normal. A small amount of compost will complement the addition of mycorrhiza but no artificial fertilizers or herbicides should be added.

There are a few things to consider if setting up a trial. See below section on 'setting up a trial'.

<u>Inoculating trees, growing them from seed:</u>

Materials needed: inoculum, seeds, growing tubes or plant pots, soil, compost.

Method: As shown in the diagram below, two thirds of the pot or growing tube should be filled with normal soil, with a little compost mixed in, if available. Then add a layer of inoculum and finally another layer of normal soil into which the seed is sown. The inoculum layer need only be a couple of centimetres deep. This means that when the roots grow down the tube they will come into contact with the fungus, and quickly become infected. The trees are then cared for as usual, and planted out at the same time as normal, to coincide with the growing season. The trees that have been infected with the fungus should be much better equipped to cope with shortages in rainfall, and will also improve the mycorrhizal potential of the surrounding soil.



Inoculating pre-grown trees:

Materials needed: inoculum, trees, spade.

Method: dig the hole where you will plant your tree and throw in a spade-full of the inoculum. Place the sapling in the hole and sprinkle a little more of the inoculum around the edges as you fill it in. If you are adding compost then dig the hole slightly deeper, add the compost, cover over with normal soil and *then* add the spade-full of inoculum.

Inoculating crops:

Method: Put a pinch of inoculum into any hole that you are about to plant into. Or mix a couple of handfuls of the inoculum with seeds that you are about to sow and plant as usual. If transplanting then soak the root ball in water and then dip in the inoculum. The root ball will then have a coating of inoculum. Plant as normal.

When you have used as much of the inoculum as you need, **the trap-pot or trough can be topped up again** with more starter soil, re-planted with bait plants and the cycle repeated. This ensures that there is a ready supply of inoculum all through the year.

6. Setting up a trial – things to consider

Labelling your plants

1. Keep a careful note of where each plant was planted and what treatment if any it was given. It is useful to give each plant a number.
2. Label each plant in a way that will not be destroyed by the elements. You are unlikely to remember which plants are where months later. We usually label the plants either mycorrhizal (**M**) or non-mycorrhizal (**NM**)

Layout of M and NM plants

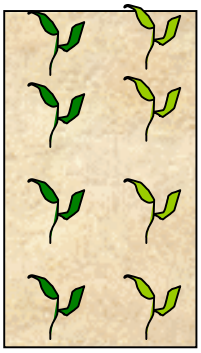
1. Do not plant too close together. Spacing them will reduce the chance of the fungi spreading to non-inoculated plants.
2. It is preferable but not essential that the treated and non-treated plants are laid out randomly. This reduces environmental factors that might affect the results. One way of doing this is a randomised block design (see below).

Designing the trial

It is worth spending some time considering where and when you want to set up the trial. How much space you have as well as the amount of care that you can give the plants. The trap-pot or trough needs to be set up **three months in advance** of your scheduled planting in order for the mycorrhizal population to fully mature.

For whatever planting you are doing try incorporating the mycorrhizal method. But if you have a blank area and would like to set up a more rigorous test of the method then below are a couple of examples of how you might lay out a trial. The first is non random (see diagram below), this has the advantage of giving a direct and easy to see comparison. However, with this layout external factors might well influence your results. For example, factors such as wind direction, shade, and soil variability could induce better growth in one side regardless of the treatment. Using a randomised block design is a fairly simple way of reducing the risk of these factors influencing your results. An example of a randomised block design is shown below.

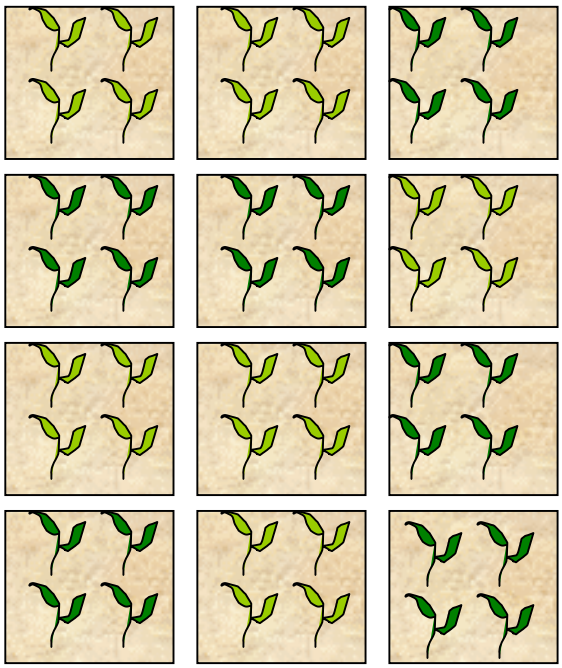
Non random



Inoculated

Control

Randomised blocks



If you have the time and resources to set up a trial we will give you all the support we can. So contact us and let us know what you have in mind.

7. How to record the progress of your inoculated and non-inoculated plants

To help you record data we have produced data sheets for measuring both survival and height. At first sight this spreadsheet may look overly complicated but **don't panic!** There are full instructions for filling out all the information. We have also included an example data sheet of measurements from trials in Tanzania. The data shown in these examples is not real data, but should give a good idea of how we would like your data to be presented. If you have any problems at all then contact us and we can help.

You will need to keep a regular check on the plants that you are growing. In particular there are two key measurements that we would like to receive information on: 'survival' and 'height'.

Survival is simply a matter of recording the number of inoculated and control plants surviving. This is less time consuming than taking height measurements.

We would only expect **height** measurements to be taken if you are growing small numbers of plants, or if you feel you have sufficient time and labour. The system for measuring the plants needs to be consistent, using the same unit of measurement (preferably millimetres), the same instrument and if at all possible, by the same person.

The frequency of measurements is up to you, the more regular the better. Here, we measure height and survival in the nursery every two weeks, and decrease that to once a month after the plants have been planted in the field. It is recommended that the measurements be taken with an interval of not more than a month.

In addition to measurements, we would encourage additional comments on the data pages, to record information relevant to specific plants (e.g. eaten by insects, broken by children etc) and any other information about the trial and external factors in general (e.g. bad rains, widespread diseases etc). This will all be useful information for us.

We appreciate all the information that you send to us. Our aim is to trial this method in as many situations as is possible. We would not publish your results without prior permission first, and you would be acknowledged in the publication.

All completed trial proposal forms and data sheets should be sent to the Mycorrhizal Research Coordinator. Please contact us with any queries or problems with entering data on the sheets provided or if you have any problems or suggestions on how to improve this site or how to make it more accessible.

Email: sunseedspain@arrakis.es

Postal Address: Sunseed Desert Technology
APDO 9
04270 Sorbas
Almeria
Spain

Tel: (0034) 950 525 770