

Mycorrhizal mushrooms: some background and planting instructions ©

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Mycorrhizas

All the major forest species and most agricultural and horticultural species have mycorrhizas (pronounced my-core-rye-zas), beneficial, symbiotic relationships between certain fungi with the roots. The fungus gets carbohydrates from the plant and a place to live and, in exchange, the fungus supplies the plant with minerals, in particular phosphorus. Mycorrhizas fall into two groups: ectomycorrhizas where the fungus is predominantly on the surface of the root, and endomycorrhizas where much of the fungus is inside the root.

Mycorrhizal Mushrooms

Most commercial mushrooms are grown in factories where the artificial conditions are managed to ensure quality products, maximum yields and greatest profit. The button mushroom, shiitake, oyster mushroom and straw mushroom all fall into this category. Another group are formed by ectomycorrhizal fungi.

While the Périgord black truffle and the Italian white truffle are regarded as the diamonds of the mycorrhizal mushrooms, there are over 1000 species and some are in great demand with prices ranging from a few tens of dollars up to several thousand dollars per kilogram. For example, porcini and the chanterelle together have a market worth more than €1 billion. Like the vast majority of mycorrhizal mushrooms, porcini and chanterelle have never been cultivated and supplies are collected entirely from the wild.

Progress has been pedestrian since the Périgord black truffle was first cultivated in the first half of the 19th century. However, over the past 30 years scientists have begun to unlock the secrets to growing other mycorrhizal mushrooms and the wonderful array of flavours they have to offer. They have also imported these very seasonal mushrooms into the Southern Hemisphere where they can be grown out-of-season to the Northern Hemisphere. Edible Forest Fungi New Zealand Ltd was established to investigate producing edible mycorrhizal mushrooms either in specialised plantations or as secondary crops in plantation forests. The techniques that are being used differ somewhat from those that have been used unsuccessfully elsewhere and sometimes involve the inoculation of plants with more than one organism.

Benefits of truffles and other edible mycorrhizal mushrooms in plantations

The harvest and sale of truffles or mushrooms during the life of a forest will offset the cost of establishing the plantation and, under some circumstances, the income from the sale of the truffles and mushrooms may exceed the value of the timber. Even modest quantities of mushrooms or truffles may be sufficient for a grower to delay felling a plantation until timber prices are optimal.

Ecological requirements

Each of the mycorrhizal mushrooms along with their host trees require a unique set of conditions to grow and fruit. The bianchetto truffle will fruit on more than a dozen host trees. Examples include the stone pine, hazel and English oak. It also needs a high pH, lime-rich soil and an area with warm summers and cool winters. In New Zealand it has been cultivated in Te Puke, Waipukurau and West Melton, near Christchurch, whilst in Europe it fruits from just north of Edinburgh to as far south as Sicily.

The painted suillus only grows on Douglas fir and in relatively low pH, free-draining soils, and in sheltered areas between 300 m and 800 m in the North Island, such as on the volcanic plateau, and up to 700 m in the South Island.

The saffron milk cap only grows on acidic soils such as those suited to radiata pine. In New Zealand it has fruited from just north of Dunedin to Nelson in the South Island and as far north as Gisborne and the Waikato in the North Island. Because it grows widely in Scotland it should also grow in Southland.

The Burgundy truffle is widespread throughout Europe and fruits well from as far north as the island of Gotland off the east coast of Sweden to the warmest parts of Europe. In New Zealand a few Burgundy truffles have been found south of Oamaru.



Almost all of the edible mycorrhizal mushrooms fruit in autumn (e.g. saffron milk cap, painted suillus, porcini, Burgundy truffle) or winter (bianchetto truffle and Périgord black truffle) while a few can occasionally be found fruiting in spring (e.g. porcini).

Edible mycorrhizal mushrooms in plantation forestry

Edible mycorrhizal mushrooms grow on a variety of plantation forest species familiar to the New Zealand forester. However, the initial treatment the mycorrhized trees receive is somewhat different from the two slots in the ground with a spade and heel-ing in that a plantation forest tree might get. The minimum tree specifications that a forester might expect are also unlikely to be met because the mycorrhized trees are raised under specialised conditions in a greenhouse and are planted when the trees are adequately mycorrhized even if relatively small.

Planting density

The density required for truffle mycorrhized trees is dependent on a variety of things including the species of truffle and climate. Detailed information on this can be found in the book "Taming the Truffle" by Ian Hall, Gordon Brown & Alessandra Zambonelli (available from Amazon). For non-truffle mushrooms standard plantation forestry densities can be used, 3 m x 3 m for radiata pine and even higher for Douglas fir.

Planting instructions

We recommend that trees are not stored before planting so make sure your soil and everything else is ready before you take delivery of your trees. If for any reason you absolutely must delay planting make sure that you water the plants regularly but without overwatering and don't store them near or under ectomycorrhizal trees because these could contaminate your trees. If you are not sure what plants form ectomycorrhizas download the file "Lists of arbuscular mycor-

rhizal plants suitable for windbreaks around truffières and unsuitable ectomycorrhizal plants" from www.trufflesandmushrooms.co.nz Under no circumstances should you store trees in leaf inside a darkened room such as a garage.

Trees that carry edible mycorrhizal mushrooms such as the saffron milk cap, come in a variety of containers such as special slotted trays constructed to stop root spiralling, black polythene planter bags, and paper-like bags (Melfert bags). If you have purchased plants that have been raised in black polythene planter bags and from suppliers other than De Licio® you should contact them for planting instructions.

Early Spring planting is preferable, late July in, for example, Gisborne, and late August or early September in the cooler parts of the country. The one exception is where the African black beetle is common. Although this beetle normally lives on pasture species it is not too particular and can ring bark young radiata pine, oaks and hazel. Consequently, wherever the African black beetle is found we recommend planting in late January or February.

Irrigation is strongly advisable as is some form of tree protection at least until the tree roots have grown out of the potting mix and into the surrounding soil. In these regards all trees mycorrhized with edible mycorrhizal mushrooms are initially treated like truffle trees (see Taming the Truffle).

Plant during dull, overcast conditions when there is not much wind. Do not plant in full sunlight. This is because the trees do not have access to much water in their containers and can dehydrate in a matter of hours. This might set back their growth by months if not permanently. Plants that have been raised in, for example, Lannen trays can be planted directly into the planting hole without prior treatment. It is impossible to remove Melfert bags (photo below) and instead these should be cut top to bottom in three places around the bag before planting. Plant the trees so that the root ball is just covered by the soil to a depth of about 1 cm. Irrigate once or twice daily to begin with and make sure that the irrigation water is penetrating to a depth below the roots of the plants and not just the top few centimetres of soil.

Maintenance of trees

Where there are browsing animals such as hares and in windy areas there are considerable advantages from protecting trees with tree guards or tree shelters. In the Périgord black truffle industry and on Jeff Weston's productive bianchetto



truffière, 600 mm (high) x 150 mm KBC Tree Guards have been successful (available from, for example, Newfield Marketing, Christchurch, 03-348 0799) although a range of other products are available such as Tubex Shrubshelters (see "Taming the Truffle, p. 138). We have not observed any problems associated with high temperatures inside Tree Guard boxes providing there has been adequate irrigation. However, for plantations in the hotter parts of New Zealand it would be worthwhile getting local advice from other growers, garden suppliers nurserymen etc.

Also cutting several vertical holes with a rotary saw at the lower end of the boxes will help convection currents to develop inside and cool the trees.

Yields and returns

Although Périgord black truffles have been grown commercially since 1997 the cultivation of other edible mycorrhizal mushrooms is still very much in its infancy in New Zealand. Consequently there is insufficient information available to allow us to predict what yields can be expected in all parts of New Zealand. All we can do at this stage is to quote what a few growers have achieved.

In most saffron milk cap plantations between Te Kuiti and coastal North Otago, fruiting started when trees were about 2 years old. On Hannes and Theres Krummenacher's irrigated saffron milk cap plantation near Nelson, yields were estimated to be 60 kg/ha after 2½ years, 1 kg/tree in the 6th year and an average of 6 kg/tree in the 9th year. On the summer-dry site in North Otago the best plants produced 20 relatively small mushrooms whilst others have yet to fruit. This plantation was established on the boundary of a 20 year old radiata pine plantation and contamination from it may have had detrimental effects on yields. In mature plantation forests annual yields of both the saffron milk cap and painted suillus have far exceeded 100 kg/ha.



The Périgord black truffle has yielded best in the warmer parts of New Zealand whereas fruiting of the bianchetto truffle so far has been satisfactory at West Melton near Christchurch. It is too early to predict what quantities of bianchetto can be expected from plantations but 20 kg/ha after 8 years is probably not an unreasonable expectation with yields hopefully increasing over the following decade.

In New Zealand prices charged for the saffron milk cap have been around NZ\$40/kg whilst retail prices in upmarket stores in Portugal and Spain, where the saffron milk cap is highly regarded, are around €40/kg. In New Zealand, first grade bianchetto truffles uncontaminated with poorer flavoured species, such as *Tuber maculatum* (this is sometimes called the New Zealand white truffle), are selling for upwards of NZ\$2500/kg (plus GST) at the farm gate during the winter harvest. In Italy, bianchetto mixed with some poorer flavoured truffles wholesales for about €500.

What to do, where to go

Information on the cultivation of truffles can be found in the book Taming the Truffle by Ian Hall, Gordon Brown and Alessandra Zambonelli. Other edible mycorrhizal mushrooms are covered in a series of information sheets and detailed booklets that have been prepared by Truffles and Mushrooms (Consulting) Limited. These are available from Ian Hall, P.O. Box 268, Dunedin 9054, New Zealand, truffle1@ihug.co.nz, +64-3-454 3574, +64-27-226 1844, www.trufflesandmushrooms.co.nz