Mycorrhizal mushrooms: some background and planting instructions

Mycorrhizas
All the major forest species and most agricultural and horticultural species have mycorrhizas (pronounced my-core-rye-zas), which are beneficial, symbiotic relationships between certain fungi and the roots of most plants. 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.
Since the introduction of new techniques for cultivating the Périgord black truffle in the early 1970s, progress in the Northern Hemisphere has been pedestrian. 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. 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 the Périgord black truffle and bianchetto fruit during winter while the Burgundy truffle fruits in autumn and early winter. In contrast, the saffron milk cap, painted suillus and porcini while occasionally these might be found fruiting in spring.

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 heeling 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.

Suillus lakei, an edible species on Douglas fir

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 although it is generally better to be more generous and space the trees at 5 m or more.

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.

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 mycorrhizal plants suitable for windbreaks around truffières and unsuitable ectomycorrhizal plants” from Truffles and Mushrooms (Consulting) Ltd. 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 you should contact the producers 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 pines, oaks and hazels. Consequently, wherever the

African black beetle is found we recommend planting in late January or February.

Plantec-Lannen trays (above) are popular in forestry.

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Fullpots are one of the containers we use

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 by Ian Hall, Gordon Brown and Alessandra Zambonelli).
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, Plantec-Lannen trays and Fullpots 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 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.

Various tree guards have been successful. We have not observed any problems associated with high temperatures inside them providing there has been adequate air circulation and 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. In the 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 a 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 summer parts of New Zealand whereas fruiting of the bianchetto truffle so far has been adequate in various parts of New Zealand. It is too early to predict what quantities of bianchetto can be expected from plantations but 20 kg/ha after 10 years is probably not an unreasonable expectation.

In New Zealand retail prices for the saffron milk cap have been around NZ$30/kg while in Australia A$40 is more likely for quality mushrooms. Prices in upmarket stores in Europe 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), sell 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 wholesale for about €400.

What to do, where to go
Information on the cultivation of truffles can be found in the book Taming the Truffle. 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 either available on https://trufflesandmushrooms.co.nz/ or directly from Ian Hall, P.O. Box 268, Dunedin 9054, New Zealand, truffle@trufflesandmushrooms.co.nz, +64-3-454 3574.

Saffron milk cap mycorrhizas