

Chapter 2: Inoculation

Equipment

Proper tools and equipment can make inoculation fast and easy. For any operation, a high-speed drill, inoculation tool, wax baster, and a stove to heat the wax are essential (Figure 2).



Figure 2. Having the right tools to inoculate shiitake mushrooms will make the job much easier and faster. It would cost \$500 to purchase the tools shown in this picture.

Inoculation

Inoculation is the introduction of the live fungus into the log. This live fungus is mixed with sawdust, grains, and other nutrients or is grown on a wooden dowel. This mixture, called spawn, is the mycelium of fungi growing on a substrate and prepared for propagation of mushrooms. Mycelium is a network of hyphae or the vegetative portion of a fungus. The mycelium runs through the log or substrate like the roots of a plant run through soil.

Logs should be inoculated only if the daytime temperatures are consistently above 50 degrees F. In warm climates, it may be possible to inoculate October through mid-December and to begin again in February.

Logs are sometimes too dry to inoculate. Logs with moisture content of less than 40 percent should be soaked for 1 to 3 days or until the desired moisture level is reached. Methods of determining moisture in logs are explained in Chapter 5. The logs must be inoculated right after soaking and then immediately stacked in a laying yard or house.



Figure 3. Convert an angle grinder into a high-speed drill with this specialized adaptor. It fits on a 5/8-11 spindle. This adaptor works only with high-speed drill bits.

To inoculate, drill holes into a log and then fill with spawn. Drill a 5/16-inch diameter hole 1 inch deep for dowel spawn and a 7/16-inch diameter hole 1 inch deep for sawdust spawn. A high-speed 1/2-inch or 3/4-inch, 8,000 rpm drill works best to drill a large number of logs (Figure 2). However, a lower priced alternative is an angle grinder with a high-speed drill bit adaptor (Figure 3). The angle grinder may be slower to use because two hands are generally needed to hold the grinder, and you cannot rotate the log as holes are drilled. For rapid colonization of the log, the following drilling pattern is used:

Starting 2 inches from the butt end, drill the first hole in the row (Figure 4). Drill the second hole 5 to 8 inches from the first and so on down the length of the log until the other butt end is reached. Place the next row of holes 2 to 4 inches below or above the first row and stagger the holes between the holes in the first row. Continue this pattern around the whole log. Avoid letting soil or debris con-



Figure 4. Drill logs from one end, spacing holes in the row about 5-8 inches apart. Roll log and stagger the next set of holes about 2-4 inches below or above the first set. Continue drilling around the entire log.

taminate the inoculation holes. Inoculation rates, or the number of holes drilled, can be increased for quicker colonization, but this will also increase the amount of labor and cost per log for spawn. Rates of 30 inoculation sites per 10 pounds of log significantly increase yields over 5 or 10 holes per 10 pounds of log.

After the holes are drilled, the log should be inoculated as soon as possible to prevent drying and contamination. To inoculate with dowel spawn, place a dowel over the hole and tap it into place with a hammer. Poke a thumb inoculator into a container with spawn to fill the tube. When it is full, hold the inoculation tool over the drilled hole and press the thumb plunger. This will fill the hole with spawn to the bark level. If spawn protrudes above the bark, either press it into the hole or wipe off the excess.

Sealing the Inoculation

When the holes are filled with spawn, seal with hot wax as soon as possible to prevent drying and contamination. Several kinds of wax can be used. Paraffin is commonly mixed with up to 20 percent mineral oil, by volume, to improve the flexibility of the seal. Cheese wax is softer and more pliable so it does not require additional mineral oil. Beeswax can be used, but it often attracts bees when heated.

To apply, heat the wax until it smokes (about 260 degrees F) and with a wax baster (metal turkey baster), apply just enough to cover the spawn and seal the hole. The wax will bubble slightly and dry in a thin, clear layer. This may kill the spawn on the surface of the hole, but most of the spawn will be unaffected because the wax cools rapidly. The hot wax will also surface pasteurize the inoculation site and reduce the potential for contamination. The ends of the logs can be dipped in the wax pot or brushed with heated wax (Figure 5). Some producers prefer not to wax the ends of the logs because they feel water absorption is slowed during soaking. On the other hand, in hot, dry climates, excessive moisture can be lost from unsealed log ends. Hot wax can injure people and damage property so keep a fire extinguisher available as well as small chunks of wax to place in the pot to cool down the wax.

Figure 5. The ends of the logs should be dipped in hot wax or brushed with wax, in southern climates, to reduce moisture loss and contamination.



Labeling the Logs

Label logs with the inoculation date and strain of spawn used. Strains fruit at different temperatures so labeling the logs lets you know when to soak each strain. Use various colors of spray paint to indicate soaking "seasons" or temperatures. Be sure you keep a list of which colors are used for each strain or groups of strains. For example, blue paint can be used for strains that fruit when the log temperature is between 52 and 56 degrees F. When the average daily temperature reaches 50 degrees F in the spring and 58 degrees F in the fall, these blue-edged logs should be soaked in preparation for fruiting.

Spawn Growth

Sawdust spawn, when placed in the log, generally has higher moisture content than the log. This causes the moisture to move away from the spawn into the log. If too much moisture is lost, the spawn will dry out and die, therefore, it is important to provide a cool, moist environment for newly inoculated logs and to provide supplemental moisture if logs begin to dry. To reduce spawn moisture loss and log drying, apply a good seal over the inoculated spawn and bulk-stack the logs for a month or two. Logs left outdoors can be covered with burlap or other porous materials that will allow moisture to enter and reduce drying. Be sure to monitor inoculation sites for green *Trichoderma* growth (Figure 6). If *Trichoderma* appears, increase log ventilation and/or reduce the humidity around the logs.

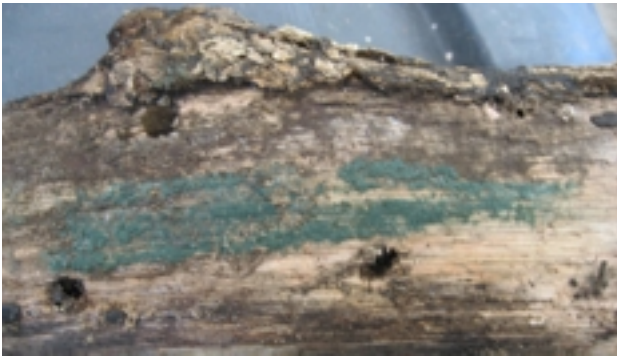


Figure 6. *Trichoderma* is an invasive green fungi that can reduce yields of mushrooms by competing for nutrients and space in the substrate.

After inoculation, observe the growth of the spawn every 30 days. The spawn can usually be seen growing right through the wax by the change in color. At first, the color is light; then it becomes pure white. This may take a while in winter, but in spring, this may only take 1 to 2 weeks.

Mycelium Run

Spawn growth appears as white patches around the inoculation site and the ends of the logs. This means the mycelium in the spawn mixture has recovered from the inoculation process and resumed growth. When this recovery

occurs, the mycelium will grow through the substrate like plant roots through soil. During mycelium run, the log environment must be managed by controlling moisture and air circulation. In the winter months, there is generally enough rain to stabilize moisture. But moisture may need to be applied by irrigation in a dry year.

Under good growing conditions, mycelia often appear at the end of the logs. It appears white in a pattern related to the inoculation sites closest to the end of the log (Figure 7). It may later turn dark brown or black. When a log is colonized, it does not have to be inoculated again.



Figure 7. Mycelia will appear at the end of the logs when it begins to run. The white pattern often reflects the inoculation hole pattern at the end of the log.