

Shiitake Mushroom GARDENING

Introduction

Home production of shiitake (she-TAH-kee) mushrooms can be a rewarding and delectable hobby. They can be grown year-around indoors and out; on hardwood logs or blocks of sawdust; with a concerted all-out effort or just casually. You will never get mushrooms this fresh from the supermarket produce section.

Shiitake mushrooms are good to eat, an excellent source of protein, trace minerals, B and D vitamins, and low in both fat and calories. Shiitake mushrooms also have been proven to reduce cholesterol.

Shiitake mushrooms do not bruise easily and can be stored for up to a month if harvested at the right time and refrigerated in "vegetable bags." They can also be dried and stored in sealed plastic bags for up to 2 years.

Growing shiitake mushrooms does require patience. You can establish a shiitake garden by purchasing or cutting your own logs in the dormant season, and inoculating them yourself. It will take 6 to 12 months for these logs to produce mushrooms. For those with less patience, you can buy sawdust blocks or preinoculated logs. You should be able to fruit them right away.

Preparing For Inoculation

Picking The Right Shiitake Strain

If you inoculate the logs yourself, order your spawn (the form of the shiitake fungus that grows through the log) from a reputable dealer 1 to 2 months before you plan to cut your trees. Spawn producers may not have the most desirable strains available if you wait too late to order. Give the spawn dealer your desired shipping date so your spawn will be as fresh as possible.

Fruiting Temperature Requirements

There are several shiitake strains (varieties) available. They are usually categorized by fruiting temperature requirements. Shiitake will generally fruit (form the edible mushrooms) at log temperatures between 41 and 86°F.

- Cool season strains fruit at 41 to 68°F.
- Wide range strains fruit at 50 to 80°F.
- Warm season strains fruit between 50 and 86°F.

Strains may also vary in productivity, appearance, mushroom size and length of time it takes to fruit.

Environment

Select strains that will fruit in the environment where you plan to develop your shiitake garden. If you plan to use the shade of a maple tree, inoculate logs with a warm season strain for summer fruiting. If you want to harvest mushrooms in winter, inoculate logs with a cool season strain. A wide range strain can be used for spring and fall production. Logs grown indoors should be inoculated with a strain that grows at the temperature of the growing room you plan to use.

Condition and Appearance Of Spawn

All strains can be purchased as sawdust or dowel spawn (Figure 1). Your spawn should be white and fluffy when you receive it (Figure 1). There should be little or no liquid in the bottom of the bag. If there are green patches (Trichoderma, a weed fungi), contact the vendor and ask for new spawn.



Figure 1. Dowel (left) and sawdust spawn (right) are used for log inoculation.

If the spawn is brown and loose, the mycelium is not well knitted and it was sent to you before it was ready for you to use. You can store unknitted spawn at about 65 to 70°F in a moist environment for a few weeks, to see if it will turn white, or you can return it and ask for your money back or a white bag of spawn. If you receive your spawn more than a few days before you plan to inoculate, you should place it in the refrigerator or a very cool basement. Move spawn to room temperature about 24 hours before you plan to inoculate. When ordering a preinoculated log or sawdust block, make sure you tell the supplier the fruiting temperature conditions, so you will get the right inoculated strain.

Selecting The Best Trees

Type

The three types of trees most often used for production of shiitake mushrooms are white oak, red oak, and sweetgum. White oaks are the most productive and are bothered the least by invasions of foreign or weed fungi. But, white oaks require the most patience, since it usually takes 8 to 12 months from inoculation before the mushrooms first begin to fruit.

Red oak and sweetgum have softer wood and will produce mushrooms in 6 to 8 months. They also require more careful management since they are more susceptible to other fungi, bark peeling, and rapid water loss.

Shiitake mushrooms will also grow on American hophornbeam, ironwood, laurel oak, cherry, sassafras, sycamore, tulip poplar, and hickory. How well the shiitake mushrooms grow on logs from these trees depends on how much care you give the logs and how well you control moisture, temperature, and exposure to other fungi. Other types of trees can be used for growing shiitake mushrooms, but under the best of conditions, you will only harvest a few mushrooms per log.

The actual location of the growing tree is also important. The more fertile soils will produce trees with more nutrients and sugars. Trees located on rocky hillsides and in very wet sites are less nutrient rich.

Area Of Sapwood

Since shiitake mushrooms feed primarily on sapwood, trees selected for inoculation should have a large sapwood area. You can determine the area of sapwood by looking at the end of a log after the tree has been cut. Most of the trees in a particular area will have similar sapwood to heartwood ratios. The lighter or outermost wood is the sapwood and the darker or inner wood is the heartwood (Figure 2). A small amount of sapwood means that the log will probably produce mushrooms for less than 2 years.



Figure 2. The lighter, outermost wood is the sapwood and the darker, inner wood is the heartwood.

Cutting And Buying Shiitake Logs

Cutting

Logs should be harvested during the dormant season from live, healthy trees. Cutting your own logs is an option only if you have a chain saw and easy access to hardwood trees. Be sure you take a buddy along if you cut your own logs. If you can, cut the tree down 7 days before you plan to inoculate. Logs can then be cut to size and moved to the inoculation site immediately.

Trees left in the woods should remain uncut and untrimmed for 7 to 10 days. Then, cut them to size and inoculate within a few days. The diameter and length of the log will depend on how heavy you want your logs. A log 40 inches long, 8 inches in diameter will weigh about 60 pounds. A log 40 inches long, 4 inches in diameter will weigh about 25 pounds.

Buying

Buying logs to inoculate can be difficult because the logs must not be split or the bark damaged. They must also be of the type, length, and diameter you specify. Most log cutters will charge from \$0.50 to \$1.00 for a log 40 inches long and 4 to 6 inches in diameter. Agree to accept and pay for only those logs meeting your specifications.

Equipment And Supplies

There are several tools necessary for inoculation and there are some that just make inoculation easier. Where possible, several options for equipment or supplies have been given (Figure 3).

- Drill with depth stop
- $\frac{5}{16}$ (dowel spawn) or $\frac{7}{16}$ (sawdust spawn) inch bit
- Spawn gun (sawdust spawn) or hammer (dowel spawn)
- Wax (cheese, paraffin, bees', candle, etc.)
Option: foam plugs
- Pot or kettle for wax
- Source of heat (propane stove, electric burner, etc. if using wax)
- Metal baster for wax (plastic and glass basters are okay)
Option: a natural fiber brush
- Bathroom scales (to weigh some of the logs)



Figure 3. Equipment and supplies used for inoculation of logs. From left to right: cheese wax, propane stove, wax pot, wax baster (front), foam plugs (front), propane canister (rear), inoculation tool (front) spawn (rear), high speed drill, $\frac{7}{16}$ inch bit with collar stop and screw tip.

Inoculating The Logs

Drill holes, 1 inch deep, into the log in a diamond pattern ($\frac{7}{16}$ inch diameter for sawdust spawn, $\frac{1}{2}$ inch for dowel). The first row of holes is drilled down the length of the log, with each hole 4 to 6 inches apart (Figure 4). The second row of holes should be staggered with the first row and 2 inches from it. Continue this pattern around the log (Figure 5).



Figure 4. Drill down the length of the log.

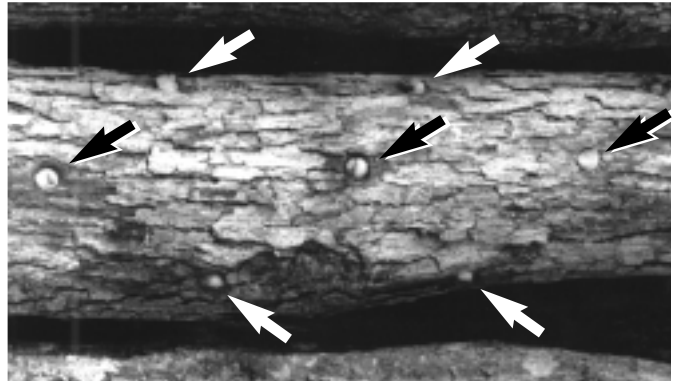


Figure 5. Close-up of the drilling pattern of a log.

Inoculate the logs immediately after the holes are drilled. The inoculation tool will fill the holes to the bark level with sawdust spawn (Figure 6). Use a hammer to securely insert dowels into the drilled holes. Spawn can be placed in the holes by hand if you do not have an inoculation tool. This method is time consuming and exposes the spawn to more contaminants.



Figure 6. Inoculation of log with inoculation tool and sawdust spawn.

Once a log has been inoculated, it should fruit for 2 to 3 years. Reinoculation is not necessary because the mycelium grows throughout the log, like roots in soil. The mushroom develops when the mycelium has accumulated sufficient nutrients and the temperature and moisture requirements are met.

Waxing The Logs

The inoculation sites and the ends of the logs are generally coated with wax. This reduces moisture loss and keeps the spawn or dowels securely in the hole. Logs kept in an indoor, humid (90 percent humidity) environment, will not need their ends waxed. If you use foam plugs to secure the spawn or dowels in the holes and do not want to use wax to seal the log ends, keep the logs in a humid environment or mist the logs daily during warm and hot weather.

Immediately after inoculation, seal sites with wax or place foam plugs in the holes.

1. The wax should be heated until it begins to smoke slightly (about 260°F).
2. Using a baster, squeeze a light coat of wax over the inoculation sites to cover the holes (Figure 7). You can also use a natural fiber brush to wax the inoculation sites.

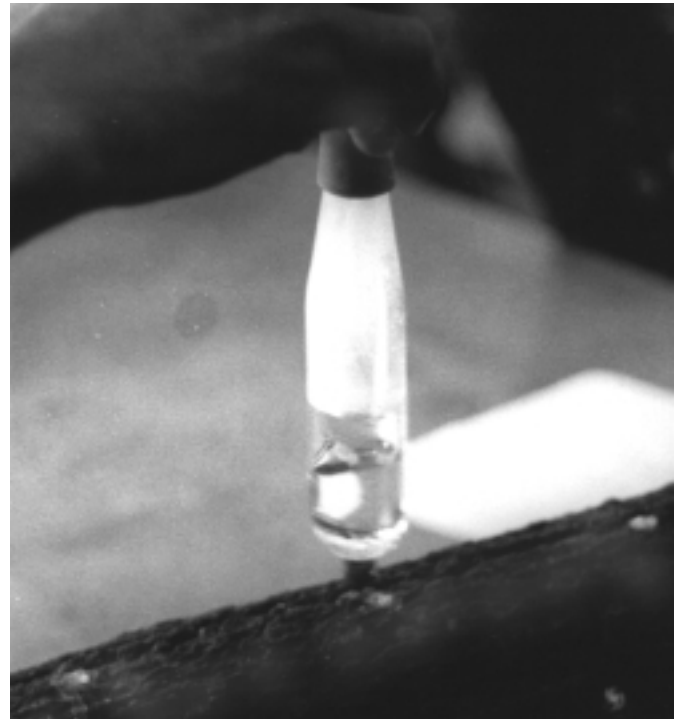


Figure 7. Baste inoculation sites with hot wax.

3. Dip the ends of the logs into the wax or brush them with wax to seal them. This will also slow down the invasion of foreign fungi through the ends.
4. Poke foam plugs into the inoculation sites. This usually requires a blunt object, smaller in diameter than the plug, to push it in the top of the hole.

Log Moisture

Monitoring Moisture

To determine if your logs are losing too much water, weigh at least one average size log immediately after inoculation:

1. Mark that log with paint or a tag.
2. Weigh the log, and record the weight.
3. Reweigh the marked log(s) every week. To determine weight loss, use this formula:

$$\frac{[(\text{Original log weight} - \text{Current log weight}) / (\text{Original log weight})] \times 100 = \% \text{ moisture lost.}}$$

If your answer is greater than 10 percent, you will need to mist or water your logs more often. As the mycelium grows and uses up the nutrients, the log will naturally lose weight.

To reestablish a new “base weight” or to replace the “original log weight after inoculation,” you will have to reweigh your log every 6 months. To obtain a new “original log weight:”

1. Soak the log for 48 hours.
2. Remove it from the water and allow it to drain for 24 hours.
3. Weigh the log. This weight will be your new base weight.

Many shiitake gardeners learn to “feel” the moisture in their logs just by picking them up. If they seem light, then they know they have not applied enough water.

Unless you are going to fruit your logs, it is best not to soak the logs to restore moisture. Soaking the logs at the wrong time can cause a break in the mycelium growth cycle and prolong the time from inoculation to fruiting or between fruitings.

Keeping The Logs Moist

You can use lawn sprinklers, misters, or a greenhouse mist system to keep the logs moist. Logs should be given a fine mist from 8 or 9 in the morning until 6 or 7 in the evening during the heat of the summer. If you are using a lawn sprinkler, watering this long will cause the bark to fall off of the logs. Lawn sprinklers can be turned on for about 4 to 5 hours in the heat of the day. There is no need to water or mist your logs if they are outdoors and it is raining. During spring and fall, when the temperatures are below 80°F, you can water less often. If you plan to fruit logs in the winter, water them weekly.

Mycelia Run

The Waiting Period

Once a log is inoculated, mycelia (root-like structures) must become organized and grow to take up nutrients and carbohydrates (sugars). Like roots, mycelia need plenty of moisture and a compatible temperature. Place logs in a warm, 65 to 80°F location in the garage or basement during the winter months.

Weigh your control log every few weeks. If it loses more than 10 percent of its weight, sprinkle or mist all of the logs for several hours each day until the original weight is restored.

Beginning in March, outdoor logs will need to be moved to a shady location and kept moist. Many gardeners cover their logs with burlap to keep in the moisture.

Stacking Logs

Logs can be stacked several ways during this time. The most important factors are good aeration, moisture, and temperature. If logs are leaned against a tree or “A-frame” stacked, they will tend to lose moisture rapidly (Figure 8).



Figure 8. Logs stacked against a shade tree. Typical of an A-frame stack.

“Lean-to” or “criss-cross” are the best methods of stacking for mycelium run (Figures 9 and 10). If logs are stacked like firewood, they receive little aeration and the mycelium in the bark knits the logs together.



Figure 9. The lean-to stack is one of the best methods of stacking logs during mycelium run.

Fruiting The Logs

Wide Range Strains

If you keep your logs outside, the natural fruiting seasons are spring and fall. The weather changes then, and there is plenty of moisture. Soak the logs with wide range strains in March and September for 24 to 48 hours. I have used the bathtub and a large trash can for soaking. If the log does not completely fit in the trash can, soak it for 24 hours and then turn it end-for-end and soak another 24 hours. Then lean them against a tree or fence.

Warm Season Strains

Outdoor logs inoculated with warm season strains can be fruited in June or July by soaking them in very cold water and keeping the log moist or misted until pins appear.

Cool Season Strains

Logs with cool season strains should be brought indoors during cooler months, to a warm location for 1 to 2 weeks and then soaked for 48 hours. After soaking, locate these logs where air temperatures will remain above 40°F at all times. Fruiting will be slower in winter, but the mushroom quality is excellent.

Pinning & Fruiting

When the logs begin to fruit, you will first see a small whitish knob emerging from the inoculation sites. These little knobs or “pins” (primordia) will develop into mushrooms, if the log and air temperature and moisture are right.

Provide heavy shade at this time or newly formed mushrooms will dry out. Do not spray or wet mushrooms while they are developing. This will cause soft mushrooms that will not store well. If mushrooms get wet from rain, eat them right away or dry them. If your logs are indoors, and you can control the temperature, you will be able to fruit your logs more frequently by soaking them every 10 to 12 weeks.

Preinoculated Logs

Preinoculated logs are available from some commercial producers and a few mail order companies. Prices range from \$18.00 to \$45.00 for a log 4 to 6 inches in diameter and 18 to 24 inches long. The logs are ready to fruit and even come with directions and a soaking container. You will be able to fruit these logs every 10 to 12 weeks for about 2 to 3 years.

Figure 10. The criss-cross stack is also one of the best methods of stacking logs during mycelium run.

When you unstack them at a later time, it causes the bark to pull off of the logs. This causes bare spots on the log where moisture loss can occur. Weed fungi contamination at these sites is also a problem.

Logs will begin to show signs of mycelia run or mushroom activity in about 3 months. The inoculation sites will turn whitish first, and then the logs will have white “V-shaped” markings on the outer one-third of the ends of the log (Figure 11). Fruiting will generally not begin for 6 to 12 months after inoculation, depending on the type of wood and the strain of shiitake mushroom you used.



Figure 11. Logs will begin to show signs of mycelia run or mushroom activity in about three months. These are the white areas on the end of the log.

Sawdust Blocks

For the less patient gardener, sawdust block kits cost \$15.00 to \$30.00 each and must be ordered from a shiitake spawn vendor (Figure 12). They are made from hardwood sawdust, grains, and other additives necessary for mycelia growth.



Figure 12. The white sawdust block (right) is about 2 months from fruiting, while the brown block (left) can now be removed from the bag and fruited.

The ingredients are placed in a heat resistant bag and are then autoclaved (which is similar to pressure cooking). After the ingredients cool, shiitake spawn is added to the bag mixture and the bag is sealed. Each bag has a small breathing patch for air exchange. As mycelia grow, the sawdust mixture turns white. When the entire mixture is coated white, this is called a “white block.” A white block is not ready to fruit.

During the next 2 months, the white block will gradually turn into a “brown block.” The brown coating is a hardened shell that helps prevent moisture loss and contamination. When the block is completely brown, you can remove it from the bag and it will usually fruit without soaking. In most cases, you can buy the blocks at either stage.

After the block is removed from the plastic bag, keep it in a humid location, where it is exposed to outdoor or fluorescent light. Fruiting should begin within a few days. After all of the mushrooms are harvested, the block will enter a resting state. Sawdust blocks will need some daily misting or a humid environment. You will be able to fruit them again in 3 to 4 weeks by soaking for 12 to 24 hours. Blocks will rarely fruit more than five times.

Often, blocks become contaminated and can only be fruited a few times. You can harvest up to 1 to 2 pounds of shiitake mushrooms from each block. The first two harvests will produce more mushrooms than later harvests (Figure 13).



Figure 13. You can harvest several pounds of shiitake mushrooms from a sawdust block.

Harvest

The mushrooms can be harvested at any time by cutting or twisting the stem off of the log. However, mushrooms are best if harvested shortly after the gills are exposed (Figure 14).

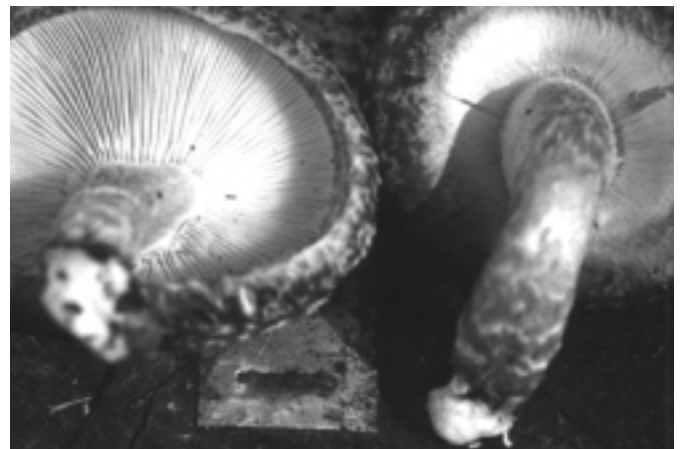


Figure 14. Shiitake mushrooms store better if harvested shortly after the veil breaks and the gills are exposed. Gills are fully exposed on the left and the veil has not broken on the right.

Storage

If you store your fresh mushrooms in the refrigerator in vegetable bags, they will last up to a month. If you refrigerate them in paper bags they will eventually dry.

You can also dry them using a food dehydrator:

1. Cut off the mushroom stems before dehydration.
2. Remove individual mushrooms as they become just barely flexible, but before they are crisp.
3. Store dried mushrooms in a sealed plastic bag.
4. Place them in the freezer for 72 hours.

You can then keep them frozen or remove them from the freezer and store them in a dry location.

Rehydration

To rehydrate shiitake mushrooms, soak them in water or a seasoned liquid or broth for at least 30 minutes. Shiitake mushrooms absorb flavors of seasonings. They taste best when cooked with onion, leek, or garlic. They are excellent in sauces, stews, or rice, and with eggs or steak.

Glossary

- **Dormant**—Season when hardwood trees lose their leaves. This is generally from mid-October to mid-March.
- **Inoculation**—The introduction of spawn into a medium, logs, sawdust, etc.
- **Mycelia**—The plural of mycelium.
- **Mycelium**—The vegetative part of a fungus made of a mass or network of threadlike tubes.
- **Spawn**—The vegetative growth or pure culture mushroom mycelia on a suitable sterilized substrate such as various agars, grains, or wood chips.
- **Substrate**—The material in which the shiitake mycelia grows. This includes logs, sawdust, grain, etc.
- **Weed fungi**—Fungi other than shiitake that invade a log inoculated with shiitake spawn.

Supply And Material Sources

Some sources of the supplies and materials mentioned are listed below with the following designations: Sawdust blocks (S); Inoculated logs (L); Tools and Supplies (T). There are also various WEB sites that list suppliers.

Field and Forest Products (S), (T)
N3296 Kozuzek Rd.
Peshtigo, WI 54157
(715) 582-4997

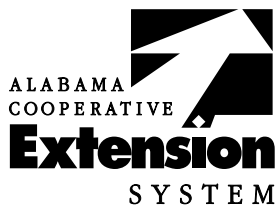
Fungi Perfecti (S), (T)
P. O. Box 7634
Olympia, WA 98507
(800) 780-9126

Fungus Among Us (S)
P.O. Box 352
Snohomish, WA 98291
(360) 568-3403

Lost Creek Mushroom Farm (L)
P.O. Box 520
Perkins, OK 74059-0520
(800) 792-0053

Mushroompeople (T)
P. O. Box 220
Summertown, TN 38483
(800) 692-6329

NOTE: Trade names are used only to give specific information. The Alabama Cooperative Extension System does not endorse or guarantee any product or producer and does not recommend one product or producer instead of another that might be similar.



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