Abstract. Preparation and use of tightly knit disks of grain-splay mycelium capable of immediate growth as inoculum in growing different mushrooms on logs is described. The aluminum foil used to form a disk is tightly molded over the cut-end surface of the log to hold the inoculum disk in place. This method of inoculation is quick and convenient, saves spawn material and labor, and ensures complete spawn coverage of inoculation surfaces to virtually eliminate contamination by other microorganisms. Grain-splay disk inoculum was used successfully to inoculate logs with various mushroom species; e.g., *Pleurotus* sp., *Lentinus edodes*, *Auricularia* sp., and *Flamulina velutipes*.

About one-third of the presently cultivated mushrooms can be produced on logs; e.g.: shiitake mushroom, *Lentinus edodes* (Berk.) Sing.; oyster mushroom, *Pleurotus* sp.; wood's ear, *Auricularia* sp.; jelly fungus, *Tremella* sp.; winter mushroom, *Flamulina velutipes* (Fr.) Sing.; and “Nameko”, *Pholiota nameko* (T. It) S. Ito et Imai. Cultivation of the shiitake mushroom, commercially the second most important mushroom in the world, is just beginning in the United States and Europe (6, 8, 9). Although straw is mostly used now in commercial production of oyster mushrooms (11), there is renewed interest (2, 7) in earlier cultivation methods using logs (1, 10).

In cultivating mushrooms on logs, the logs are inoculated with mushroom mycelium either by inserting mycelium-colonized wooden plugs or sawdust through the bark or by spreading mycelium-colonized cereal grain (i.e., grain spawn) on the cut-end surfaces of logs. In Asia, wood-plug or sawdust inoculum is used commonly to cultivate various different mushrooms on logs. The drilling of holes and insertion of inoculum required for 15–20 inoculations per log, however, is laborious and time-consuming. In Europe, grain spawn was used early to cultivate oyster mushrooms (10) and, recently, to cultivate shiitake mushrooms on logs (8). The use of grain spawn inoculum in cultivating various different mushrooms on logs would be advantageous because of the available technology for preparing grain spawn of the cultivated mushroom, *Agaricus brunneescens* (Peck). The use of grain spawn to inoculate logs, however, has several disadvantages.

In removing grain spawn from its container, the mushroom mycelium grown on the grain substrate necessarily is disrupted completely just before its use as inoculum. Reestablishment of *A. brunneescens* mushroom mycelium occurs on pasteurized compost in the protected environment of a mushroom house, but disrupted grain spawn mycelium placed on log cut-end surfaces is vulnerable to contamination by numerous, diverse microorganisms. Despite the presence of these competitors, disrupted mycelium of vigorous pure-culture grain spawn usually is reestablished readily on such cut-end surfaces. However, because it is difficult to achieve or maintain complete coverage of...
cut surfaces with a layer of moist grain spawn, peripheral contamination by other molds may occur. Once peripheral contamination is established, the entire cut-end surface often becomes contaminated. Incomplete spawn coverage can be a consequence of the method used to hold the spawn in place. Methods used have included placing a layer of grain spawn between logs (25-cm-diameter) stacked vertically (10); covering a spawn-filled incision with plastic film (8); and covering spawn on a cut-end surface with a 3-cm-thick log disk nailed to the log (7). In addition, covering cut-end surfaces of logs with a necessarily thick (2.5-cm) layer of moist grain is slow and laborious.

The purpose of this report is to describe an improved method of inoculating logs with mushroom grain spawn to produce mushrooms. The method is applicable to all mushroom species capable of being cultivated on logs.

Grain-spawn substrate (175 g rye grain, 20 g mixed wood shavings and sawdust, 2 g CaCO₃, and 225 ml tap H₂O in a 2-liter flask fitted with a cotton stopper) was sterilized in a steam sterilizer by "precooking" at 100°C for 90 minutes, followed immediately by 90 minutes at 121°C at 1 kg/cm. The cooled, sterile grain substrate was inoculated with a 1-cm² block of mycelial inoculum from a mushroom culture grown on potato dextrose agar. The culture was shaken at intervals of 2–5 days, depending on the species of mushroom and the condition of incubation to obtain rapid and complete colonization of the substrate. When the substrate was completely colonized (10–30 days), it was shaken to break up all clumps and poured onto aluminum foil and spread evenly by hand to form a circular layer (15–30 cm diameter) of grain spawn about one grain thick (Fig. 1a). The inclusion of shavings and sawdust helped to minimize clumping of grain and allowed colonized grain to be spread easily in a thin layer. The layer of grain was covered with another sheet of aluminum foil, and the edges of the 2 sheets folded together to form an envelope securely enclosing the disk of spawn grain. Satisfactory spawn disks also were prepared using very thin wrap-type

![Fig. 1](image-url)
translucent polyethylene plastic film instead of aluminum foil. Although spawn disks were not made aseptically, gross contamination was avoided by first covering the table surface with a fresh sheet of paper and wearing a plastic glove or bag when spreading the spawned grain.

The envelopes of spawn disks were incubated (22° to 26°C) for 7–30 days depending on the mushroom species. Vigorous growth of mushroom mycelium soon resulted in the formation of a tightly knit disk of grain spawn within the envelope (Fig. 1b). Growth was monitored by partially opening a foil envelope or by observing directly through the plastic wrap. Stacking of more than 4 envelopes during incubation was avoided because of the high temperatures (33° to 37°C) developed in taller stacks as a result of spawn growth metabolism.

Using spawn disks, logs were easily and quickly inoculated with mushroom mycelium. At the forest site (7° to 30°C), one layer of aluminum foil was peeled away easily from the spawn disk. The mycelial mat was examined visually and any contaminated disks discarded. The presence or absence of characteristic odors was helpful also in evaluating mycelial mats. This capability to assess culture purity—not possible in the usual use of spawn—may be an important advantage of the spawn-disk method. Without touching the spawn, a mycelial mat having a diameter equal to or slightly greater than that of the log was applied to the cut-end surface of the log and held securely in place by tightly folding and crimping the aluminum foil around the bark. For added protection, the previously peeled-away sheet of aluminum foil was used also to cover the end of the log, providing a cap consisting of 2 layers of aluminum foil (Fig. 1c). Separate sheets of aluminum foil were used similarly to hold the spawn disks formed in plastic-film envelopes. When required, spawn disks were pulled apart easily to fit small or irregularly shaped areas. Colonization of the log by the already established mushroom mycelium begins soon after inoculation. The complete coverage of cut surfaces by growing mushroom mycelium vigorously under the aluminum-foil cap virtually eliminated contamination of inoculations sites by other microorganisms.

Cut-end surfaces, an important source of water loss, usually are not covered in traditional cultivation of the shiitake mushroom. To promote growth of mushroom mycelium in the logs, the logs are kept in protected environments ("laying yards") to moderate temperature fluctuations and to minimize water loss. The growth of contaminant fungi in the high humidity conditions of such laying yards, however, is a major cause of decreased mushroom yield (5). Aluminum foil-capped logs, however, can lose moisture only by transpiration through the bark (3, 4). In these studies, inoculated logs supported by cinder blocks to prevent contact with the soil were kept outdoors in a clearing in a second-growth deciduous forest at the Beltsville Agricultural Research Center, Beltsville, Md. (Fig. 1d).

Little or no sustained drying occurred in logs during the May–November period under the temperature and rainfall conditions at Beltsville (7). In addition, because the logs were not enclosed, insect damage and growth of "green molds" on the logs (none at caps) were negligible.

Grain-spawn disk inoculum was used successfully to inoculate logs with a variety of different mushrooms; e.g., Pleurotus sp. (Fig. 1e), L. edodes, Auricularia sp., and F. velutipes. The biological and practical advantages of the use of mycelial mats of grain spawn to inoculate logs should promote the cultivation of mushrooms on logs.

**Literature Cited**


### Chemical Dormancy Breaking of Red Raspberry

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**Additional index words.** *Rubus idaeus*, dormancy breaking, cyanamide

**Abstract.** Several chemicals, used to induce budbreak of deciduous fruit trees in areas lacking sufficient chilling units were applied to 3 cultivars of red raspberry (*Rubus idaeus* L. cvs. Delmes, Malling Exploit, and Schoenemann) grown in Bet Dagan, Israel. All treatments including oil + dinitro-o-cresol (5%), KNO₃ (5%), thiourea (1%), and cyanamide (4%) solutions improved budbreak, and increased yield. The most impressive effect was obtained with 4% cyanamide, which increased fruit size, earliness, and yield.

Growing deciduous temperate zone fruit trees in subtropical countries raises problems of poor sprouting of the buds in spring, followed by low yields of fruit due to the insufficient chilling units in the subtropical areas. To improve the termination of bud rest, special treatments of chemical sprays in the winter were developed (2, 5). Treatments used commercially to break the dormancy are oils, oil + dinitro-o-cresol (DNOC), potassium nitrate, and thiourea solutions. Another chemical, calcium cyanamide, has been used successfully on apple, pear, and peach (3).

<table>
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<tr>
<th>No. fruit laterals per cane</th>
<th>Treatment</th>
<th>Feb. 9</th>
<th>Mar. 4</th>
<th>Mar. 24</th>
</tr>
</thead>
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<tr>
<td>Control</td>
<td>5.46 b</td>
<td>5.46 d</td>
<td>5.46 c</td>
<td></td>
</tr>
<tr>
<td>Oil + DNOC</td>
<td>7.46 b</td>
<td>8.00 c</td>
<td>8.23 b</td>
<td></td>
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<tr>
<td>KNO₃</td>
<td>7.85 b</td>
<td>9.30 b</td>
<td>8.61 bc</td>
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<tr>
<td>Thiourea</td>
<td>8.15 b</td>
<td>10.15 b</td>
<td>8.08 b</td>
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<tr>
<td>Cyanamide</td>
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<td>11.90 a</td>
<td>9.69 a</td>
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*Mean separation within columns by Duncan’s multiple range test, 5% level.*

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