MINIMALLY COMPOSTED SUBSTRATE FOR PRODUCTION OF AGARICUS BISPORUS

Stephanie Loehr
Outline

- Introduction
- Objectives
- Results
Mushroom Cultivation Today

- Relies entirely on composted substrate

- Common ingredients include:
  - Straw-bedded horse manure, hay, poultry manure, distiller’s grain

- Raw materials account for 20-45% of costs
Environmental Impacts of Composting

- Offensive odors result from microbial activity
  - Nuisance complaints due to increased suburbanization

- Runoff may contaminate surface and groundwater

- What to do with spent mushroom substrate?
Offensive Odors

- Offensive odor result from anaerobic fermentation during phase I composting

- Odors include:
  - Hydrogen sulfide
  - Sulfur compounds
  - Ammonia
Minimal Composting

- **Goals:**
  - Increase grower profits
  - Minimize offensive odors
  - Eliminate some of the environmental impacts of the composting process
Objectives

1. Develop protocol for phase II composting ONLY of corn stover substrate

2. Determine the effect of particle size of milled corn stover on mushroom yields of *A. bisporus*
Objectives

3. Evaluate the use of nutrient supplements
   1. Prior to phase II composting
   2. At spawning
   3. At casing

4. Determine the effect of spawn rate and type on mushroom yield
Corn Stover

- Consists of:
  - Stalks
  - Leaves
  - Shucks
  - Cobs

- Roughly 20% H₂O
- Up to 80% of stover can be removed from no-till fields

Baled corn stover

Wally Wilhelm, 2007
Preparation of Corn Stover for Mushroom Substrate

Chopping and Shredding

Wetting
Add MnSO₄, lime mix, supplements

Fill mini-bunker

Spawn

Phase II composting
Chopping and Shredding

Bale Chopper

Mighty Mac shredder

0.635cm
1.27cm
1.91cm
Wetting

- Water added to achieve 72-75% moisture
- $\text{MnSO}_4$ added
  - Corn stover is deficient in manganese
  - Manganese peroxidase is important enzyme in lignin degradation
- Lime mix is 2:1 of agricultural lime: hydrated lime
Corn Stover Phase II Composting
Phase II Temperature Profile

Day

Temperature (°C)

High
Middle
Low
Fragmenting, Supplementing, and Casing

Fragmentation of colonized substrate

Cased small bin

Cased bins at MRC
Ready to Harvest
Objective 2

- Determine the effect of particle size of MCS on mushroom yields of *A. bisporus*

<table>
<thead>
<tr>
<th>Screen Size (cm)</th>
<th>Particle size &lt;3 mm (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.64</td>
<td>89.22</td>
</tr>
<tr>
<td>1.27</td>
<td>79.93</td>
</tr>
<tr>
<td>1.91</td>
<td>58.38</td>
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</tbody>
</table>
The effect of particle size on mushroom yield

![Graph showing the effect of particle size on mushroom yield.](image-url)
Objective 3a

- Determine the effect of various nutrients added prior to phase II on mushroom yield

<table>
<thead>
<tr>
<th>Additive</th>
<th>Nitrogen content (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cottonseed meal</td>
<td>7.0</td>
</tr>
<tr>
<td>Ground soybean</td>
<td>6.0</td>
</tr>
<tr>
<td>Soybean meal</td>
<td>8.0</td>
</tr>
<tr>
<td>Distiller’s grain</td>
<td>4.5</td>
</tr>
<tr>
<td>Spent mushroom substrate (SMS)</td>
<td>1.6*</td>
</tr>
</tbody>
</table>
Supplementing prior to phase II composting
Supplementing with SMS prior to phase II composting

![Graph showing the effect of SMS addition on Yield and BE%]

- **Yield (kg/m²)**
  - 0% addition: a
  - 22.4% addition: a
  - 48% addition: a

- **BE (%)**
  - 0% addition: b
  - 22.4% addition: b
  - 48% addition: a

*Note: Different letters indicate statistical significance.*
Objective 3b

- Evaluate the use of various delayed-release nutrient supplements added to MCS at spawning and casing

<table>
<thead>
<tr>
<th>Supplement</th>
<th>Protein Content (%)</th>
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<tbody>
<tr>
<td>Lambert T6</td>
<td>44</td>
</tr>
<tr>
<td>Lambert T7</td>
<td>66</td>
</tr>
<tr>
<td>Remo’s All Purpose</td>
<td>55</td>
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Supplement type at casing on mushroom yield and biological efficiency

<table>
<thead>
<tr>
<th>Supplement at Casing (5 % d/w)</th>
<th>Yield (kg/m2)</th>
<th>BE (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>T6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Remo's</td>
<td></td>
<td></td>
</tr>
<tr>
<td>T6 + Remo's</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*6 % d/w T6 at spawning
Objective 4

- Evaluate colonization and mushroom yield for two different types of spawn (millet, Matrix®)
The effect of spawn type on mushroom yield and biological efficiency

- Matrix
  - BE (%)
  - Yield (kg/m²)
  - BE (%): a
  - Yield (kg/m²): b

- Millet
  - BE (%)
  - Yield (kg/m²)
  - BE (%): a
  - Yield (kg/m²): b
The effect of spawn rate on mushroom yield and biological efficiency
Summary

- Modified phase II composting is sufficient to impart selectivity on MCS for *A. bisporus*

- Smaller particles gave higher yields than larger particles

- Cottonseed meal addition (10% d/w) prior to phase II composting significantly increases mushroom yield and BE
SMS can be added to MCS prior to phase II composting without significantly decreasing mushroom yield.

5% (d/w) T6 + Remo’s at casing gave highest yields.

Matrix spawn gave higher yields in MCS substrate than millet spawn.

Typical spawn rates can be used for MCS substrate.
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