AUSTRALIA

USE OF SPENT COMPOST AS A CASING MATERIAL

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INTRODUCTION:

It has been known in mushroom cultivation, since the 17th century, that "casing" of compost with a suitable material was essential to induce the development of fruit bodies in any quantity so that the importance of obtaining the most suitable material for casing cannot be overemphasized.

Various materials are used for casing throughout the world and appear to give satisfactory results. The casing material has changed radically in the past twenty years. An unsterilized or unpasteurized loam top soil was originally used. More recently, the soil is pasteurized or treated chemically. In the United States several mushroom growers use a loam top soil. Growers in Chester County, Pennsylvania, generally use a silty clay loam of limestone origin and growers in Berks County, Pennsylvania use a sandy clay loam of an origin other than limestone. Soil is not used in France, where soft marl dug out of quarries is pulverized and used for casing. A Swiss farm uses a mixture of soil, weathered spent compost and ground tuff which is removed from the mushroom growing trays, stored for one year, pasteurized and re-used. In England, peat is mixed with ground chalk and used for casing. Australian mushroom growers rely on peat neutralized with ground limestone as their casing medium. Peat is relatively free of pathogens and is normally used without pasteurization or chemical treatments.

Peat is expensive to purchase in Australia; currently costing about $9 to $12 per bale. It has been estimated that mushroom growers in Australia spend from $5,000 to $20,000 a year on peat. In order to reduce this cost it has become essential to find a suitable alternate casing material. This is currently receiving priority in the mushroom research programme of the Department of Agriculture at the Biological and Chemical Research Institute, Rydalmere.

THE RESEARCH PROJECT

The project involves a study of the feasibility of recycling spent compost for use as a casing material. To do this, it is necessary to understand the exact means by which the casing layer influences the formation of mushroom fruiting bodies. Research has therefore been carried out along the following lines:

(a) The effect of soluble salts on fruit-body formation.
(b) Microbiological factors in spent compost casing affecting initiation of fruit-bodies.
(c) Concentration of gaseous oxygen and carbon dioxide in spent compost casing stimulating fruit-body formation.
(d) Physical properties of spent compost casing.

The soluble salt level in spent compost at any particular period during its decomposition would depend on the initial level of these salts. It is, therefore, difficult to fix a standard period of time needed for weathering spent compost before its use as a casing material. Results of experiments so far carried out have shown that natural weathering of locally available spent compost for about two years brings about, through leaching, a reduction in its soluble salt content sufficient to permit the formation of mushroom fruit-bodies. An increase in the time of weathering resulted in an increase in the leaching of soluble salts.

It would appear that provided the soluble salt level in the compost is below 1000 parts per million, the yield of mushrooms is not reduced. A general pattern in the breakdown of major and minor elements in spent compost over a period of eight years are given in Tables 1 and 2. With increased time of weathering, analyses have shown that the level of a number of major and minor elements decreased. These were phosphorous, potassium, magnesium, sodium, manganese and zinc. However, levels of nitrogen, calcium, copper and iron did not decrease significantly with time of weathering. Experiments are in progress to determine if there is a correlation between the decreasing levels of the elements referred to above and an increase in yield of mushrooms.

Micro-organisms in the casing layer multiply by using the accumulated volatile

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gases produced by the mushroom mycelium in the bed beneath. At the same time the metabolites (chemicals) produced by these micro-organisms stimulate the mushroom mycelium to initiate fruiting bodies. The numbers of these micro-organisms, which are of a group of bacteria known as Psuedomonads, have been found to be significantly higher in spent compost than in peat.

Indeed in spent compost their numbers are optimal for the stimulation of fruit-bodies and tests, using both spent compost and peat as casing, have shown that significantly higher initiation of fruit-bodies occurs with the spent compost casing. It has not been possible to show that the final yield obtained is significantly greater with spent compost casing than with peat casing.

The physical properties of the casing layer are also known to play a critical role in formation of fruit bodies. It must have good aggregation and an ability to hold water without breaking down, slaking over or sealing. If sealing takes place before the mycelium has penetrated the casing layer no mushrooms will form. The value of peat moss as a casing material is its ability to retain its porous structure, natural air-holding capacity and high water-holding capacity. Examination of spent compost after 1 1/2 to 2 years weathering shows that it will seal less readily than either peat or the soil types used for casing under local conditions and, repeated watering does not appear to impair its physical structure. Spent compost generally has a pore-space of 45 to 50% of its total volume. In trials, spent compost also retained the optimal physical condition for adequate gaseous exchange in either direction between the air above and the compost beneath. This was demonstrated when materials such as rice hulls, lime chips, etc. were added to spent compost. The addition of such materials is expected to open up the structure of spent compost.

HANDLING OF SPENT COMPOST FOR CASING.

Pasteurization of recycled compost is essential to eliminate many pathogens and competitors of the mushroom. This can be achieved by treating it with aerated steam at 60°C (140°F) for 30 minutes. Pasteurization with aerated steam selectively destroys many pathogenic micro-organisms while allowing micro-organisms antagonistic to the pathogens and micro-organisms which stimulate fruit body formation, to survive.

Some general points that are relevant to the use of aerated steam for heat treatment can help in the preparation of spent compost for this treatment.

(1) Steam moves in soil through continuous pore spaces and on coming in contact with cool particles it condenses, releasing a large quantity of heat. The air in the soil pores is driven out during diffusion of steam. It is essential to provide facilities for removal of this air.

(2) Steam moves upwards through soil twice as fast as it moves downward or laterally. The displaced air moves out freely from the surface of soil. Steam should, therefore, be applied from beneath soil.

(3) A given soil has a maximum condensing rate and if this is exceeded "blow outs" occur and steam is lost from the soil. This can be avoided by properly balancing the steam flow rate and the quantity of soil treated.

(4) Soil to be treated should be screened. Steam penetration is poor in compacted soil.

(5) Pathogens and weed seeds are more sensitive to heat when moist than when dry. The sample being treated should, therefore, be relatively moist.

(6) A temperature of 140°F for 30 minutes will kill all pathogenic fungi, bacteria and nematodes. This treatment will also kill all virus-infected fungal spores and mycelium. If the treatment temperature exceeds 140°F. the soil will be sterilized leading to a "biological vacuum". Recolonization by pathogenic and non-pathogenic micro-organisms is rapid in such soils.

(7) The treated soil can be cooled readily by means of filtered air using absolute filters.

Management practices vary depending on the type of casing material used by the mushroom growers. The technique of watering, for instance, is different for peat, soil and spent compost. To prepare spent compost for casing, the grower needs

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TABLE 1

A General Pattern in the Breakdown of Chemicals in Spent Compost

Spent Compost	Nitrogen (%)	Phosphorus (%)	Potassium (%)	Calcium (%)	Chloride (%)	Magnesium (%)	Sodium (%)
At the end of cropping	1.92	0.90	1.70	4.07	0.83	0.55	0.06
1-2 years old	1.75	0.62	1.78	6.75	1.55	0.60	0.46
2-5 years old	1.99	0.53	1.27	6.55	1.35	0.61	0.39
5-8 years old	1.12	0.47	0.48	7.52	0.45	0.48	0.14

TABLE 2

A General Pattern in the Breakdown of Trace Elements in Spent Compost

Spent Compost	Manganese (ppm)	Copper (ppm)	Zinc (ppm)	Iron (ppm)
At the end of cropping	341	20	124	4010
1-2 years old	292	18	641	3820
2-5 years old	248	14	144	3990
5-8 years old	181	26	150	5690

land. Experience in the United States has shown that if the same square footage is filled with compost for three years, then 60 - 70 per cent of the total amount put to weather will be used. On the basis of this figure a grower can calculate the amount of compost produced in his farm and how much area will be required to spread that amount of compost to a depth of about 0.6 metres. If this depth is exceeded leaching will be inefficient and anaerobic conditions will develop in the compost. For instance, a sample taken from a heap of weathered spent compost 3 metres deep was found to contain 15,000 parts per million of soluble salts--after two years of weathering compared to a heap of spent compost 0.6 metres deep containing 1050 parts per million of soluble salts after the same period of weathering. It is desirable to choose a land with low water table so that spent compost can be leached out efficiently during rain. Mechanical turning of the spent compost would facilitate the process of weathering.