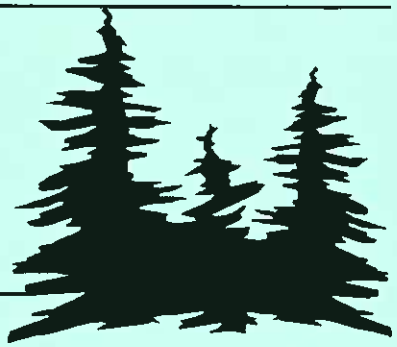
Joint Legislative Air and Water Pollution Control and Conservation Committee

Green Paper

Environmental Issue Monograph



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THE ISSUE:

MANAGING SPENT MUSHROOM SUBSTRATE (SMS) IN PENNSYLVANIA

By

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Introduction

Pennsylvania's mushroom farms, from production and harvesting, to packaging and distribution, support a billion dollar industry that brings jobs and revenue to the Commonwealth. Pennsylvania growers have developed a reputation for producing quality mushrooms in North America through their dedication to a high level of management and innovation during the production process.

The production of mushrooms generates large volumes of spent mushroom substrate (SMS). For the purpose of this "Green Paper," mushroom substrate describes the composted material used to grow a crop of mushrooms, whereas SMS (also referred to as mushroom compost) describes the organic material left after a crop of mushrooms is harvested. According to one estimate, more than two million cubic yards of SMS are produced annually in Pennsylvania. For many mushroom farms the disposal of mushroom compost has become a challenge.

The goal of this Green Paper is to assemble an overview of the potential uses for mushroom compost in an effort to raise awareness of its inherent worth as a value-added product and to facilitate future initiatives.

Background

Production of the white and brown Agaricus mushrooms in the United States totaled 896 million pounds during the 2012-13 growing season, with 60 percent produced in Pennsylvania. The over 60 mushroom farms that produced Pennsylvania's 544.9 million pounds of mushrooms in 2012-13 are concentrated in the southeastern portion of the state. At a value of $511 million, mushrooms are the state's largest cash crop. According to one estimate, the industry directly employs almost 10,000 workers.

Chester County has the distinction of being the "Mushroom Capital of the World," as this is where mushroom farming first began in the United States. The first cultivated mushrooms in the U.S. were grown in Kennett Square in 1896. Mushroom farms also dot the landscape in Armstrong, Berks, Clearfield, Delaware and Lancaster counties, supporting local economies and contributing to the state's economic well-being.

Currently, SMS is collected from mushroom farms for a fee. It is usually stored temporarily before being land applied or processed and bagged for sale as a value-added product to farmers, nurseries, landscaping companies, gardening supply centers and similar industries for use as a soil amendment, mulch and compost. Used mushroom compost is regarded as an agricultural waste product that still has value, as it is rich in nutrients and organic

matter which can provide benefits to other agricultural and non-agricultural sectors.

SMS Characteristics

Producing a substrate for the mushroom crop is the first step in mushroom cultivation. The recipe varies from company to company, but the major ingredients in mushroom-growing media from farms in Pennsylvania are typically recycled organic compounds. Ground corn cobs, cotton seed hulls, and hay are good sources of carbon. Poultry manure, horse bedding straw, and ammonium nitrate provide the necessary nitrogen. Air, water and a small amount of gypsum are added to balance the pH (acidity). The ingredients are weighed out, then mixed in.

At commercial mushroom farms, huge piles of these blended materials sit for about 30 days as it slowly heats up. The bacteria multiply, forcing the temperature inside the pile up to more than 170 degrees, killing any weed seeds and pathogens that might be present in the substrate. The result is mushroom substrate, which is ready to grow a crop of commercial table mushrooms.

The cured substrate is placed in wooden beds that are 60 feet long and stacked six-deep like bunk beds in dark, cool and humid mushroom production house and they are pasteurized at about 140 degrees to kill any surface disease-causing organisms and pests. Workers then inoculate the substrate with mushroom spores to enable growth.

Underground roots called mycelium grow in the substrate, fusing together to form thick strings upon which mushrooms will grow. Spawning typically takes anywhere from 14 to 21 days. Once the bed is completely covered with mycelia, a layer of peat moss is spread over the entire bed and watered to force the mycelia into the vegetative state necessary to produce mushrooms.

By introducing fresh air into the production house to lower carbon dioxide levels, immature mushroom-producing structures (pins) grow larger, passing through the button (tiny mushroom) stage to become mature mushrooms. The final step is the cropping or harvesting state, where the mature mushrooms are picked and placed into cold storage.

Large clusters of mushrooms, called flushes or breaks, are typically harvested over a three to five day period and the beds left idle for several more days while the next flush of mushrooms develops. These flushes repeat themselves five or six times over a five to six week period before production in those beds ends.

Once the mushrooms have been harvested, the beds are pasteurized again at 140 degrees, before being cleaned out. Then the entire house is sterilized, new growing substrate is added to the beds, and a new crop is now ready to be planted. The spent mushroom compost is now a Pennsylvania Department of Agriculture (PDA) accepted product and a Pennsylvania Preferred® product.

Pasteurized SMS is sometimes sold immediately after it is removed from mushroom houses; in this case it is referred to as "fresh SMS or pasteurized mushroom compost." Alternatively, the SMS can be placed in windrows and further composted for several weeks or even several months. This material is often called "weathered or aged SMS" and differs in composition and appearance from fresh SMS. Some producers blend SMS with soil to produce a ready-to-use growing medium for turf grasses and other plants.

SMS Guidelines

Although many of the ingredients that go into SMS products are similar, not all products are alike. Quality of the mushroom compost can vary depending on the ingredients, how it is produced, and how it is treated after it comes out of the mushroom production houses. For example:

- **General appearance:** The appearance of fresh SMS is similar to peat, with a light brown color and a light,

fibrous texture. Weathered SMS products should resemble dark topsoil and have a loose, crumbly structure. All SMS products to be used on turf should be free of large stones, plastic, and other objectionable objects.

- **Particle size:** The size of SMS particles can vary depending on how it is produced. For use on surface applications, the SMS should pass through a half inch screen.
- **Odor:** A good quality SMS product should have an 'earthy' aroma. It should not emit peculiar or offensive odors such as those associated with sulfur or rotten eggs.
- **Weed seeds:** If the SMS product has been properly composted and stored, weed seed contamination will not be a problem.
- **Moisture content:** The moisture content of a SMS product is important where uniform application and good mixing with soil is desired. Products with moisture contents between 30 and 50 percent are usually ideal for handling, surface applications, and soil incorporation.

In addition, SMS has a high water and nutrient holding capacity and exhibits no nitrogen draw-down problems. As an organic soil amendment, SMS supports plant growth in a variety of applications for lawn and landscaping, and inhibits Artillery Fungus in hardwood landscape mulch.

SMS Generation, Uses and Benefits

Over two million cubic yards of SMS are produced annually in Pennsylvania and finding good end uses for the product is a primary industry concern. Mushroom compost is an agricultural waste and finding local, beneficial uses of SMS as a value-added product is a top priority.

Many mushroom companies have found that by pasteurizing their spent compost, they can sell it to nurseries, landscaping companies, gardening supply centers, and the like for use as a soil amendment, and as an additive in hardwood mulch production to inhibit artillery fungus. Other commercial applications of SMS include: wetland material; storm water management basins; stream retrofit material; highway site remediation; parking lot islands; green roofs; filtration socks; compost blankets; and erosion control.

One promising management alternative is the use of mushroom compost in mine reclamation projects. Pennsylvania has 180,000 acres of abandoned mine lands (AMLs) and approximately 5,500 acres of active coal mine sites that require reclamation on an annual basis. Restoration of soil quality and productivity on these degraded lands requires large nutrient and carbon inputs and thus has been identified as a potential use for excess mushroom compost.

Application of SMS to promote growth of quick-growing sustainable grass species on AMLs within the nearby Anthracite coal region can provide an outlet for the nutrient-rich product. If applied on a broad scale in Pennsylvania, this technique would create a significant market for SMS, while simultaneously restoring soils on AMLs and using less fertilizer.

Another significant market for SMS is the reclamation of natural gas wells and pipeline right-of-ways. Each of the thousands of present and future natural gas well sites within the Commonwealth must be reclaimed, as does the ground above the thousands of miles of natural gas pipeline projects within Pennsylvania. Using mushroom compost at these project locations could provide an end use for SMS while simultaneously benefiting the environment.

Conclusion

A key point with SMS, or any other compost, organic soil amendment or fertilizer, is environmental stew-

ardship. Compost products used for agricultural crop production, horticulture plant production, gardening, or land use reclamation should be applied correctly and in the proper amount based on the original soil chemistry.

For many years, mushroom compost was mislabeled as "mushroom soil," and the product was unfortunately treated like traditional soil. As a result, Pennsylvania's mushroom industry had to deal with negative feedback while trying to explain why their mushroom compost was not behaving like topsoil. Mushroom compost is not topsoil, but rather an excellent compost useful in improving soil health and plant growth.

In conclusion, fresh mushroom compost applied to soil or incorporated into soil has many benefits. It improves soil structure, provides plant nutrients, increases plant nutrient availability, increases soil microbial populations, intensifies plant root structure, improves soil aeration, improves soil water status, and reduces soil compaction. Mushroom compost is a valuable and viable "green" product as an organic soil amendment that provides necessary micronutrients for crop production systems and other land management issues.

Editor's Note

Green Papers are issued periodically by the Joint Legislative Air and Water Pollution Control and Conservation Committee staff. As indicated by the subtitle, each Green Paper is a monograph on a specific environmental issue that has come to the attention of, or is being dealt with by, the Committee. Each Green Paper is intended to provide a more in-depth look at specific issues than normally permitted by other Committee publications, such as the Committee's monthly newsletter, the Environmental Synopsis.

The Joint Conservation Committee is a bipartisan committee consisting of 18 members of the House and Senate which conducts studies, holds hearings and makes recommendations to the General Assembly on air and water pollution laws, mining practices and land reclamation. Recent issues that the Committee has focused on include waste tire recycling and natural gas pipelines.

For more information about the Committee, or to be added to the mailing list for future Green Papers or the Environmental Synopsis, call the Committee office at (717) 787-7570.