

USING SPENT MUSHROOM SUBSTRATE AS A SOIL AMENDMENT TO IMPROVE TURF

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If you are trying to improve the quality of turf growing in poor or marginal soils, consider using spent mushroom substrate (SMS) as a soil amendment. Spent mushroom substrate (sometimes called mushroom soil, recycled mushroom compost, or mushroom compost) can improve the structure of clay soils, reduce surface crusting and compaction, promote drainage, increase microbial activity, and provide nutrients to turfgrasses. These improvements promote faster turf establishment, improved turf density and color, increased rooting, and less need for fertilizer and irrigation. Spent mushroom substrate production sites are located near areas of intensive turf use, providing a readily available source of organic matter. When considering costs, keep in mind that SMS may produce better soil and turf than equal or greater amounts of topsoil.

CHARACTERISTICS OF SMS

Spent mushroom substrate is the composted organic material remaining after a crop of mushrooms is harvested. Mushrooms are grown in a mixture of natural products, including horse-bedded straw (straw from horse stables), hay, poultry manure, ground corncobs, cottonseed hulls, gypsum, and other substances. This mixture is composted in piles or ricks, creating a dark brown, fibrous, and pliable organic growing media (Figure 1). When the composting process is complete, the media is brought into mushroom houses where it is placed into beds or trays and used as a substrate for growing mushrooms. After the mushrooms are harvested, the “spent” substrate is removed from the houses and pasteurized with steam to kill insects, pathogens, and

mushroom remnants.

Spent mushroom substrate is sometimes sold immediately after it is removed from mushroom houses; in this case it is referred to as “fresh SMS.” Alternatively, the SMS can be placed in windrows and further composted for several weeks or several months (Figure 2). This material is often called “weathered 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 turfgrasses and other plants.

SELECTING A SMS PRODUCT

Some guidelines to follow

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 in surface applications on athletic fields, lawns, or golf course fairways, the SMS should pass through a 1/2-inch screen (or be of similar size) (Figure 3). Composts with slightly larger particles can be used as soil amendments if thoroughly tilled into the soil prior to seeding or sodding.

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. Also, it should not emit a strong ammonia odor. Peculiar odors may be an indication that the product is not mature (not fully composted). Immature SMS may have adverse effects on turf and should not be used.

Weed seeds:

If the SMS product has been properly composted and stored, weed seed contamination will not be a problem. On rare occasions, SMS products are stored for long periods and neglected. In such cases, weed plants can begin to grow in the piles. If these weeds are not controlled immediately they can deposit seeds in the product.

Although a few weed seeds do not necessarily preclude the use of a SMS product as a soil amendment for turf, products containing large amounts of

weed seeds are unacceptable. If possible, inspect the production site to make sure that weeds are not growing in and around the SMS piles.

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% are usually ideal for handling, surface applications, and soil incorporation. Wet products (greater than 60% moisture content) tend to form clumps and do not spread evenly when applied to turf surfaces. Tilling wet material into soil may result in poor mixing with soil and uneven turf establishment. Wet SMS is heavy and difficult to handle.

A quick field test that you can use to determine suitable water content of SMS is to squeeze the product in the palm of your hand and watch for water oozing from the product. If water drips from the SMS upon squeezing, then the product may be too wet, and further drying should improve product handling. If the SMS remains together when you release your grip and no water drips from the product, it probably has suitable water content for spreading and mixing with soil.

Organic matter and ash content:

When using SMS as an organic matter supplement, keep in mind that not all of the product is organic matter. Spent mushroom substrate products typically contain between 40 and 60% organic matter on a dry weight basis. Organic matter content can be determined by a lab test. The most common procedure employed by laboratories, "loss on ignition," considers everything that is combustible as organic matter.

Some test labs report a value called "ash content." Ash is the mineral matter that remains after the SMS sample has been subjected to extremely high temperatures in a furnace. Assuming that everything burned-off in the furnace is organic matter, the percentage of ash in the sample can be subtracted from 100 to provide an estimate of percent organic matter. For example, an ash content of 40% indicates that there is an estimated 60% organic matter in the sample.

Carbon to nitrogen ratio:

The amount of carbon (C) relative to the amount of nitrogen (N) in a SMS product is an important indicator of nitrogen availability. The carbon to nitrogen (C:N) ratio of a product should be 30:1 or below. If above 35:1, soil microorganisms can immobilize nitrogen, making it unavailable to the turf. Most SMS products have C:N ratios well below 30:1.

Nutrients:

When compared with fertilizers, SMS products generally contain low amounts of plant nutrients. Whereas a small amount of quick-release nitrogen (ammonium) is present in SMS, most nitrogen is in



Figure 1: Ricks of composted mushroom media ready to be transported to a mushroom house.



Figure 2: Spent mushroom substrate placed in windrows. The resulting product is often referred to as "weathered" SMS.



Figure 3: Spent mushroom substrate is often passed through 1/2 inch screens before use in turf.

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Figure 4: SMS products can be applied to the soil surface in a 1 or 2 inch layer, then incorporated into the soil with a rototiller.

the organic form and is slowly available to turf. Test results of SMS products typically indicate 1.5 to 3% total nitrogen on a dry weight basis. Other nutrients found in SMS include phosphorus (0.5 to 2.0 %, reported as P_2O_5), potassium (1.0 to 3.0%, reported as K_2O), calcium (3 to 6%), and magnesium (0.4 to 1.0%).

Typically, significant amounts of SMS must be applied to supply all or most of the turf's nutrient requirements. In some cases, this can be achieved for short durations (8 to 10 weeks) with surface applications of $\frac{1}{4}$ to $\frac{1}{2}$ inch of SMS, aerated into the soil surface. In many cases, a 1 or 2 inch layer of SMS tilled 4 to 6 inches into soil can supply all of the nutrients necessary for turf growth and development for an entire year and possibly longer.

pH:

The pH of most SMS products is between 6.0 and 8.0, a range favorable for turf root growth. On rare occasions, a product may fall outside of this range. The pH of organic amendments may be detrimental to turf when very high (greater than 8.5) or very low (less than 5.5). Extremes in pH may result in reduced availability of some plant nutrients and/or aluminum toxicity problems. Fortunately, most soils are buffered against rapid and drastic changes in pH and even organic amendments with extremes in pH may not alter the overall soil pH a great deal. To be on the safe side, however, try using products with a pH between 6.0 and 8.0.

Soluble salts:

Soluble salts may be higher in SMS products than in other types of organic amendments. Whereas, excess soluble salts can cause turf injury, research conducted at Penn State shows that good quality SMS products do not contain salt levels high enough to damage turf. If you have questions regarding the soluble salt content of a particular SMS product and how safe it is to use on turf, send the product to a soil test lab that performs soluble salts analyses on composts.

Table 1: Suggested amounts of SMS (cubic yards) per unit area applied to established turf as surface applications or tilled into soil prior to establishment.

Unit area in square feet	Inches of SMS product applied				
	Surface applications	Tilled into soil			
	1/4	1/2	1	1 1/2	2
1,000	1*	2	3	5	6
5,000	4	8	15	23	31
10,000	8	15	31	46	62
20,000	15	31	62	93	123
30,000	23	43	93	139	185
40,000	31	62	123	185	247

*amounts of SMS in cubic yards rounded to nearest whole numbers.

METHODS OF SMS APPLICATION

Incorporation of SMS into soil prior to turf establishment:

In most cases, SMS products are applied to the soil surface at a rate of between a 1-inch layer (approximately 3.1 cubic yards per 1000 ft²) and a 2-inch layer (about 6.2 cubic yards per 1000 ft²) then incorporated into the soil to a depth of 4 to 6 inches. In order to obtain maximum performance from your application, make sure that the SMS product is thoroughly mixed with the soil and is not forming a layer at the soil surface (Figure 4). Depending on the product, this may require several passes with a rototiller. The lower rate (1-inch layer) is better suited for marginally good soils and the higher rate (2-inch layer) for very sandy soils, clay soils, or subsoils low in organic matter. If more than two inches are applied, it may

be difficult to mix the material 4 to 6 inches into the soil. On clay or compacted soils, it is helpful to rototill the soil first, then apply the SMS and incorporate.

Although SMS products usually supply enough nutrients for good turf establishment, in poor soils, additional phosphorus and potassium as well as starter fertilizer may be needed for vigorous seedling growth. Although many SMS products can raise the pH of slightly acid soils, soils with a very low pH (below 5.5) may require additional lime.

Surface applications of SMS on established turf:

SMS products are frequently used as surface applications (topdressings) on established turf (Figure 5). This practice provides a means of gradually incorporating organic matter into the soil without causing extensive disruption of the surface. The two most limiting factors associated with this practice are finding suitable application equipment and working the material into the soil.

Because SMS is usually light and bulky, a spreader with a large hopper is preferred. Modified manure spreaders with conveyor belts and brushes mounted on the back are ideal for spreading SMS over large areas. Conventional tractor-mounted fertilizer spreaders have been used successfully, but may require many refills. If spreaders are not available, SMS can be applied to the surface by spreading piles into a thin layer with a York rake or a grading blade.

Some landscaping companies are now using blowers mounted on trucks and fitted with large hoses or tubes for spreading fresh SMS (Figure 6). Fresh SMS is preferred because it is light and fibrous, thus it is less likely to clog hoses. This method works particularly well on sloped areas where it is difficult to operate a topdressing unit. For applications over small areas, the product can be spread with a shovel and worked into the turf with a leaf rake.

When applying SMS as topdressing, it is important to apply a thin layer (about $\frac{1}{4}$ inch) and work it into the soil. Successive applications of thick layers without soil incorporation will result in a build-up of organic matter at the soil surface that may cause rapid drying of turf roots and form a layer that restricts root growth into the soil. The best way to incorporate SMS into the soil is through aeration. A good method of incorporation is to apply the SMS product first, followed by several passes with an aerator equipped with hollow-tines and a heavy drag mat attached. The drag mat will break-up the cores and mix the compost with the soil, dragging some of the mix back into the holes. This operation is best performed during cool/moist seasons when grass is actively growing. Aeration and dragging can be stressful to the turf during hot, dry weather. sms



Figure 5: Modified spreaders with conveyer belts and brushes mounted on the back are ideal for surface applications of SMS.



Figure 6: Truck-mounted blowers fitted with large hoses are used with increasing frequency for applying fresh SMS.

*Where trade names appear, no discrimination is intended, and no endorsement by Penn State Cooperative Extension is implied.
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