

# Sustainable Urban Landscapes

Using

# Mulches

in Managed Landscapes



**T**he use of mulch in managed landscapes is increasing rapidly. Mulches are commonly used to enhance the beauty of landscapes, suppress weeds, conserve soil moisture, and buffer plants from the damaging effects of traffic and lawn equipment. Organic mulches also can improve the soil structure and increase the fertility of landscape soils, which often are compacted and lacking in organic matter, especially around newly constructed buildings. Many woody landscape plants evolved in forests where the soil is typically covered by a moist layer of decaying leaves, twigs, and branches (Figure 1). Mulching trees and shrubs can recreate some aspects of a forest's soil environment, even in sun-baked landscapes far from any forest.

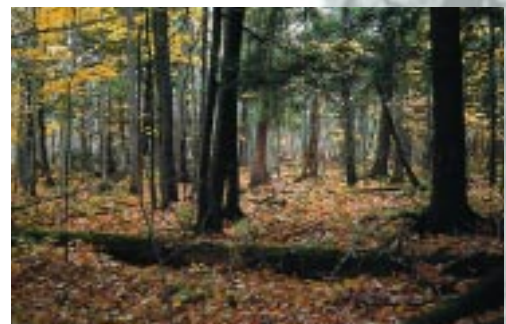


Figure 1

In a forest, the ground is covered with a layer of decaying organic matter. Many landscape trees evolved in forest environments.

However, depending on their composition and how they are used, mulches also can create problems by fostering the growth of nuisance fungi, harboring insect pests, favoring some plant pathogens, and depleting soil nitrogen and oxygen. Although recent research has taken some of the guesswork out of using mulches safely and effectively, misuse remains common. This bulletin describes the many benefits of using mulches in the landscape and provides some guidelines for their use. Many problems with mulches can be avoided by following simple precautions. When properly used, mulches provide a practical way to help woody plants survive and thrive in urban landscapes (Figure 2).

This bulletin avoids specific prescriptions for mulching because the details of appropriate mulching practices vary with differences in climate, trees species and age, soil type, management objectives, and other factors that can vary widely even among neighboring landscapes. Instead, the objective of this bulletin is to provide the information necessary to make appropriate decisions about the use of mulch in diverse landscape situations.

### Types of Mulch

A wide range of products is available for use as landscape mulch. First, mulch can be broadly categorized as inorganic or organic. Inorganic mulches, which decay slowly if at all, offer the advantage of low maintenance. Crushed stone and gravel are probably the most commonly used inorganic mulches in landscapes, and will be discussed later in this bulletin. The use of landscape fabrics (geotextiles) as weed barriers has increased in recent years. A layer of mulch often is placed over landscape fabric to improve aesthetics and to slow degradation of the fabric from exposure to light. Other inorganic mulches, such as plastic sheeting, recycled tire chips, and aluminum foil, are not commonly used in ornamental landscapes.

On the organic side, a tremendous variety of materials derived from plants or animals have been used as mulch. These include tree bark, wood chips, grass clippings, pine needles, shredded leaves, sawdust, straw, peanut hulls, peat moss, ground corn cobs, animal manure, recycled wood and paper, and composted sewage sludge. Historically, tree bark has been the most popular material for use as mulch in ornamental landscapes. Mulch derived from the bark of mature softwood trees, including pine and cypress, is very resistant to decay. Bark from young softwood trees decomposes more quickly because it does not contain the high levels of lignin, waxes, and tannins characteristic of bark from mature trees. Hardwood bark,

Figure 2  
Mulched trees and shrubs in a managed landscape.



Figure 3  
Wood chips in these raised planters have been dyed to enhance their ornamental value.

because of its high cellulose content, also decomposes rapidly. Many so-called bark mulches also contain wood, which hastens their decomposition. Wood chips generated from pruning and removal of trees decompose faster than bark, but they contain higher levels of nitrogen, especially if foliage is present.

Materials available for use as mulch have changed considerably in recent years due to efforts to divert solid wastes from landfills. Commercial sales of mulch generated from recycled wood pallets, which are ground and painted in natural or designer colors, have increased rapidly in recent years (Figure 3). Recycled

Figure 4   
Windrows of manure undergoing a composting process.



wood, which consists almost exclusively of cellulose, decomposes much faster than bark. Yard trimmings are increasingly recycled and composted by municipalities for use as mulch and soil amendments. Composted sewage sludge and manure, which can be blended with coarser products, such as wood chips, are also increasingly available for use as mulch (Figure 4).

### Effects of Mulch on Soil Moisture and Temperature

Conservation of soil moisture and moderation of soil temperature are key benefits of mulching. Both organic and inorganic mulches increase soil moisture by slowing evaporation. As a result, mulch can increase water availability and decrease moisture fluctuation in the root zone. Organic mulches also can increase the water-holding capacity of sandy soils by increasing their organic matter content as they decompose. Inorganic mineral mulches may not conserve soil moisture as effectively as organic mulches.

Roots grow whenever and wherever environmental conditions are favorable. So, a sufficiently moist soil helps maximize root growth. Multi-year research at the Morton Arboretum in Illinois and at Cornell University in New York found that mulching with wood chips increased soil moisture and root growth. Similar studies conducted on disturbed roadside soils in North Carolina and Illinois demonstrated that mulching increased foliage development of recently transplanted trees and shrubs.

Mulching does not guarantee increased growth, however. Increased water retention can be a double-

edged sword. In heavy soils, where drainage is a problem, mulch can prolong saturated conditions, especially during spring, which can harm plant roots and favor root rot diseases. This is more of a problem with fine-textured woody or straw mulches. Partially decomposed mulches actually improve water infiltration and drainage of heavy soils by increasing their organic matter content and tilth.


It is often stated that organic mulches benefit plant roots by insulating them from temperature extremes and decreasing temperature fluctuation in the root zone. Root-zone temperatures are considerably cooler under mulch during summer than under bare soil or turfgrass. High soil temperatures have been shown to cause fine root mortality of some trees. However, results of studies on root-zone temperatures under mulch have been inconsistent.

Research suggests that mulch can either increase or decrease the incidence of winter injury, depending on the situation. Some studies have found that mulch increased winter injury of plants, possibly by increasing the density of surface roots and/or delaying acclimation by keeping the root zone warmer in the fall. Other studies, however, have found no association between the presence of mulch and winter injury. Mulch can reduce the incidence of soil heaving caused by repeated cycles of freezing and thawing. Frost heaving can severely stress plants by disturbing their root systems, particularly herbaceous perennials and newly planted trees and shrubs.


Mulch effects on root zone temperature, as well as any potential benefits or consequences for plants, will vary considerably depending on factors such as properties of the mulch, soil type, soil moisture, plant species or cultivar, and weather pattern.

### Mulch as a Protective Buffer Zone

Mulch also is valuable for what it can exclude from the zone around woody plants. As proof, consider the uneasy relationship between trees and turfgrass. Research by Gary Watson and colleagues at the Morton Arboretum showed that root density of mature littleleaf linden, green ash, sugar maple, and red maple trees was greater under mulch than in bare soil and far greater than under turfgrass. Turfgrass roots have a competitive advantage over tree roots because of their greater density and close proximity to the soil surface. Competition with turfgrass for soil moisture becomes especially problematic for trees during periods of drought. Conversely, it often is difficult to maintain high-quality turf beneath the canopies of mature trees.

**Figure 5**  Certain trees, such as this Norway maple, develop roots at or near the soil surface.




**Figure 6**  A mulched zone extends slightly beyond the drip zone of this dogwood.



A mulched zone around trees protects against mechanical injury to tree roots growing on the surface of the ground, especially for shallow-rooting species, such as silver maple and Norway maple (Figure 5). A frequent recommendation is to buffer trees and shrubs with a mulched zone that extends from near the trunk to the drip line (the area under the tree directly below the canopy) (Figure 6). Another advantage of isolating trees from turf is prevention of mower blight (mower collisions that damage the bark, cambium, and vascular tissue of trees) (Figure 7). Mechanical damage to the trunk frequently reduces the vigor and life span of landscape trees by disrupting water and nutrient translocation and by creating entry points for plant pathogens and decay-causing fungi.

### Effects of Mulch on Soil Fertility

 rganic mulches can dramatically impact soil microbial activity and nutrient availability. Mulches with a high carbon-to-nitrogen (C:N) ratio, such as hardwood bark, ground wood pallets, straw, and sawdust, can induce nitrogen deficiency in plants by stimulating microbial growth, which depletes underlying soils of available nitrogen. On the other hand, mulches such as composted yard waste and wood or bark blended with composted sewage sludge can increase soil fertility and plant growth because their low C:N ratio resembles high quality forest litter. Mulches derived from the bark of mature softwood trees, such as cypress and pine, are quite resistant to decomposition by microbes and thus have little effect on nutrient availability. The

key to understanding how different mulches affect soil nutrient availability lies in understanding the role of soil microbes in nutrient cycling and how they respond to addition of organic matter.

As with plants, soil microorganisms (fungi and bacteria) require energy and essential nutrients to grow and reproduce. Whereas plants derive their energy from carbon acquired from the atmosphere via photosynthesis, the carbon in decomposing organic matter provides soil microbes with their energy supply. However, both plants and soil microbes use the same pool of essential soil nutrients. Because nitrogen is the nutrient that most often limits plant growth, the effects of mulch on soil fertility generally is determined by how mulch impacts the outcome of competition between plants and microbes for this key nutrient.

Nitrogen and other nutrients are cycled as organic matter is decomposed by soil microbes (Figure 8). The rate of decomposition depends on the total biomass of microbes in the soil. Because microbes are generally limited by the supply of available carbon, microbial biomass can increase quickly when an easily biodegradable source of organic matter is applied to the soil surface. As microbes decompose mulch on the soil surface, they acquire nutrients from the soil below in several ways. Fungal hyphae forage for nutrients in the soil much like plant roots. Nutrients are transported toward the surface by diffusion as well as mass flow driven by evapotranspiration. Furthermore, the soil is worked continuously by earthworms, insects, and natural weathering processes, which stir the nutrient pool and incorporate decomposing organic matter.

Figure 7

Injury to the base of a tree caused by collisions with a lawn mower.

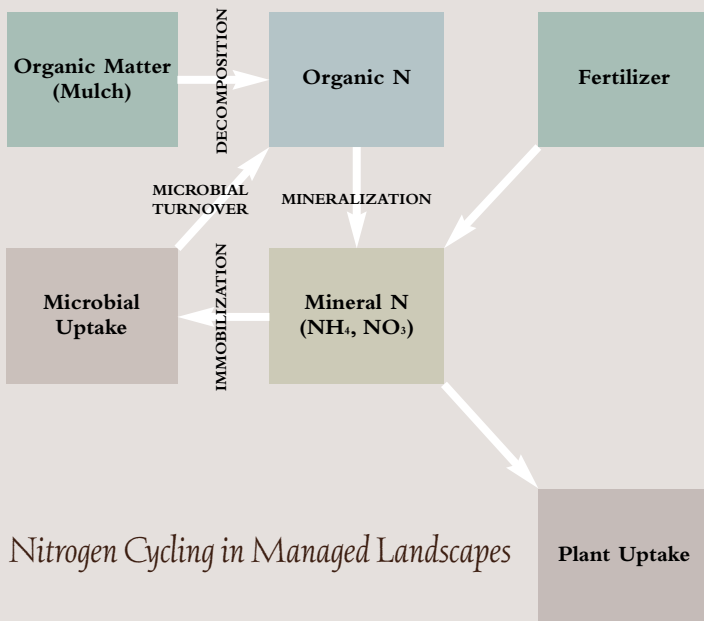


Figure 8

The role of organic mulch in nitrogen cycling in managed landscapes.

In a process known as nitrogen mineralization, inorganic forms of nitrogen (ammonium, nitrite, and nitrate) are released from organic matter as it is decomposed. Once in mineral form, nitrogen can be taken up and used by plants and microbes. Any nitrogen acquired by microbes becomes unavailable to plants. This process is referred to as nitrogen immobilization. Microbial turnover occurs as microbes die and

decompose, which releases nutrients that can be acquired by living microbes or plants.

The amount of nitrogen available for plants is determined by the net balance between the rate of nitrogen mineralized from decomposing organic matter and the rate at which nitrogen is immobilized by growth of soil microbes. Microbes are stronger competitors than plants for nitrogen. Microbes generally out-compete plants for nitrogen in soils where nitrogen is limiting, which results in plant nutrient deficiencies and decreased plant growth. In fertile soils, there may be enough nitrogen to adequately support both microbial and plant growth.


The balance between nitrogen mineralization and immobilization is strongly influenced by the C:N ratio of the decaying organic matter. Because soil microbes are generally carbon-limited, the addition of organic matter to the soil stimulates microbial growth. Organic matter with a high C:N ratio (greater than 30:1) does not contain enough nitrogen to fully support microbial growth. Therefore, microbes must scavenge additional nitrogen from the soil as they decompose high C:N mulch, which decreases the amount of nitrogen available to plants. Adding nitrogen fertilizer to high C:N mulch (1–2 lbs N/1000 ft<sup>2</sup> is often recommended) can relax nitrogen competition between plants and microbes and stimulate plant growth. Conversely, decomposition of organic matter with a C:N ratio less than 30:1, which contains more nitrogen than required to support microbial growth, increases the availability of nitrogen for plants.

Researchers at The Ohio State University confirmed these responses in a comparison of two organic mulches that differed dramatically in C:N ratio—ground wood pallets with a C:N ratio greater than 100:1 and composted yard waste (a composted blend of stems, branches, leaves, and grass clippings) with a C:N ratio of 17:1. After only one season, both mulches increased soil organic matter content and microbial biomass, indicating that microbial growth was limited by carbon even in a soil that initially had an organic matter content of 4 percent. The effects of the two mulches on nitrogen availability, however, varied dramatically.

Mulching with ground wood pallets induced a nitrogen deficiency in river birch, yew, and rhododendron, as evidenced by decreases in both foliar nitrogen concentration and plant growth. Fertilization substantially increased the growth of plants mulched with ground wood by relaxing competition for nutrients with soil microbes. On the other hand, mulching with composted yard waste substantially increased total soil nitrogen and nitrogen mineralization rate, which increased the growth of all three species. Fertilizing

Figure 9   
Piles of composting wood chips.



Figure 10   
Mycorrhizae (the white strands attached to the brown roots of this woody plant) are specialized fungi that enhance the functioning of roots.



plots mulched with composted yard waste had no effect on plant growth, indicating that nutrients released by decomposition of this mulch were able to fully meet both microbe and plant requirements.

The nitrogen-depleting effect of mulch diminishes over time as mulch decomposes. As microbes die and decompose, the nitrogen they contain is released for use by plants unless the carbon source is replenished (e.g. by adding fresh mulch). Nitrogen immobilization by microbes will have a greater impact on herbaceous plants and newly transplanted woody plants than on well-established trees and shrubs. Nevertheless, it may be best to reserve mulches with a high C:N ratio for use away from plants, such as on paths and under playground equipment. Alternatively, these products can be blended with composted materials with a low C:N ratio, such as yard waste, animal manure, or sewage sludge. Wood chips from branches and fallen trees often are recycled as mulch on the property where they were generated. This material contains more nitrogen than pure wood, especially if foliage is present. If possible, composting wood chips before use in piles up to 10' to 12' tall will further decrease their C:N ratio because carbon is lost as CO<sub>2</sub> during the decomposition process (Figure 9).

A decade of research during the 1970s showed that organic matter added to soil can increase the activity of native mycorrhizal fungi, which also can provide nutritional benefits to mulched plants. This microflora does not thrive in mineral soils devoid of biodegradable organic matter. Mycorrhizae (Figure 10) not only increase nutrient uptake, but also may protect trees from stress and even infections by plant pathogens.

### How Deep Should the Mulch Layer Be?

**B**ecause many factors should be considered when deciding how deep the mulch layer should be, general recommendations are not possible. For example, the optimal depth of mulch will vary depending on soil texture, climate, type of mulch, age of plants, and management objectives. A thin layer of mulch does not suppress weeds or conserve moisture as effectively as a deeper layer. A thin layer also needs to be replenished more often, which increases maintenance costs. On the other hand, an excessively deep mulch layer can promote waterlogging of heavy soils, decrease soil oxygen levels (see below), result in shallow rooting, and keep soils too warm during winter. Mulch can be applied under the drip line of mature trees to a greater depth than in a bed containing annual and perennial herbaceous plants. A 3" to 4" layer of mulch applied to well-drained soils in seasonally dry climates can help minimize drought stress. However, a 2" to 3" layer is more appropriate on heavy soils in regions where rainfall is more frequent.

### Effects of Mulch on Soil pH

**I**t has been suggested that prolonged use of certain mulches may impact soil pH. For example, some have claimed that acidic mulches, such as pine needles, may benefit acid-loving plants, such as rhododendrons and azaleas, by decreasing soil pH. Weathering of alkaline minerals such as limestone, as well as decomposition of bark and wood, may increase soil pH by releasing


calcium and other cations. However, most studies have found that mulch effects on soil pH are too small to have substantial impacts on nutrient availability. Studies also have shown that mulching with wood chips can help alleviate iron deficiency in oak and manganese deficiency in sugar maple. Increased availability of micronutrients in mulched soils is thought to result from chelation of micronutrients by organic compounds released from decomposing mulch, rather than from effects of mulch on soil pH.

### Soil Oxygen Depletion

If mulch is piled too deep, or if its texture is fine (for example, sawdust), air may not be able to penetrate the mulch layer, and the underlying soil becomes depleted of oxygen. In field studies at the Morton Arboretum and at Cornell University, soil oxygen depletion under wood chips was minimal even when the mulch was piled as deep as 10" to 18," but finer-textured mulches of similar depth are likely to block oxygen movement to the soil because the mulch itself uses all the available oxygen. The Cornell study also found that 3" of mulch suppressed almost all weed growth and resulted in more shoot growth on transplanted white pine and pin oak saplings than either an unmulched treatment or mulch applied to depths of 6" to 10." Excessively deep mulch also can encourage shallow rooting due to excessive water accumulation and low oxygen concentration in the underlying soil.

### Problems Caused by Mulch-to-Tree Contact

Mulch piled high against tree trunks has become a common sight in newly installed landscapes (Figure 11). There are persuasive reasons to avoid this practice, however. Trunks encircled by mulch stay constantly moist, a condition to which they are not adapted. Continuous moisture is harmful because it interferes with respiration of cambium, phloem, and other living cells in the trunk by limiting their exchange of oxygen and carbon dioxide with the atmosphere. Furthermore, this practice also creates conditions that favor infection by plant pathogens that cause fungal cankers and root rots, especially if there are trunk wounds under the mulch (also see the section below on Mulch and Plant Pathogens). Mulch piled against the trunk also may favor moisture-loving insects, such as carpenter ants, which could colonize and expand decayed areas of the trunk. To prevent these problems, it is advisable to keep mulch at least 6" away from the trunks of woody plants.

Figure 11  Mulch "volcanoes"—wood chips piled against tree trunks—are a misuse of mulch.



### Sour Mulch

The term "sour mulch" refers to the toxic nature of organic mulch produced under low-oxygen conditions. Anaerobic microorganisms are favored when excessively large mulch piles or saturated conditions limit oxygen availability. As byproducts of fermentation, they produce compounds, such as methanol and acetic acid, which are toxic to plants. Bedding plants, herbaceous perennials, and low-growing woody shrubs, such as spirea and barberry, are the most vulnerable to poisoning by sour mulch, which can result in marginal leaf chlorosis or scorch, leaf abscission, and in severe cases, even plant death. The symptoms may appear within hours to a few days after sour mulch is applied. Sour mulch can be recognized by its strong odor of vinegar or silage. Properly stored mulch will smell like freshly cut bark or fertile garden compost. To keep mulch from souring, store it on a crowned surface so that rainwater drains away. A windrow 10' to 12' high is ideal for small operations. It also helps to mechanically turn mulch piles regularly.

## Mulch and Plant Pathogens

**C**an wood chips generated from infected trees and used as mulch transmit disease to healthy trees? Several recent studies suggest that while this is possible, it is not likely under typical landscape conditions. A study at the University of Vermont showed that the nematode that causes pine wilt, *Bursaphelenchus xylophilus*, could move from fresh wood chips generated from infected trees to young Scots pines. This occurred when the chips either were incorporated into the soil during transplanting or were piled against a trunk that had been wounded. There is some reason for concern in Iowa, Illinois, Missouri, Kansas, and Kentucky, where pine wilt kills many Scots pines annually. However, pine wilt transmission via wood chip mulches is unlikely to occur under normal circumstances in landscapes if a few basic precautions are followed. Wood chips should not be incorporated into soil during transplanting, and mulch should not be piled against tree trunks. The pine wilt nematode cannot move from tree to tree on its own, and the pine sawyer beetle that normally vectors it does not colonize wood chips. To reduce the very small risk of pine wilt transmission risk to zero, it is advisable to compost fresh chips from pine wilt-infested trees for at least one month before using them as mulch around susceptible pine species.

Verticillium wilt attacks a wide range of trees, including maple, ash, catalpa, redbud, and many others. The causal fungus, *Verticillium dahliae*, lives in soil and infects plants through roots. Recent studies at the University of Minnesota found no evidence that fresh wood chips from an infected sugar maple were able to transmit the disease to Amur maple seedlings, although vegetable plants were infected when the wood chips were used as garden mulch. This study also found that storing infected wood chips in a pile for one week greatly decreased their levels of Verticillium.

Dutch elm disease and oak wilt are vascular diseases caused by fungi and spread by beetles. The beetles apparently are not attracted to wood chips. So, the risk of transmitting these diseases from chips is likely to be very small. It is not known how long these fungal pathogens survive in wood chips generated from infected trees or if they can spread to healthy trees via wounds when infected chips are piled against the trunk.

What is the bottom line regarding the risk of disease transmission from wood chip mulches to woody plants? Transmission appears unlikely under normal landscape conditions, but more research is necessary to answer the question conclusively. So, when in doubt, compost wood chips before using them as mulch. Since so-called bark mulches may contain wood as well as bark, the same precaution applies to them.

Research conducted at The Ohio State University in the early 1970s showed that temperatures in large piles of bark mulches easily reach 120-150°F. Three days of exposure to these temperatures was enough to kill all pathogens of woody plants. Numerous studies have confirmed these results. Piles should be turned two to three times to expose all portions to high temperatures.

Composting in small backyard piles (4' to 5' tall) generally is sufficient to destroy plant pathogens, even though temperatures do not reach the high levels characteristic of larger piles. In this case, the death of pathogens results from parasitism by other microbes and production of antibiotic compounds. Some pathogens may survive this process. To be sure pathogens are killed, compost in large piles at high temperature and turn the pile two to three times. The material must be moist enough (45 to 60 percent moisture) to support high microbial activity and heat output. So it may be necessary to periodically wet down the pile.

Mulches can create conditions that either suppress or favor the incidence of root rot disease in the landscape, depending on the nature of the mulch. Composted organic matter incorporated into potting media have been shown to suppress Phytophthora root rot and other root rot diseases in container-grown plants. Composts used as mulch have been shown to suppress diseases in production agriculture. Similarly, in studies at The Ohio State University, mulching with composted yard waste substantially decreased the incidence of Phytophthora root rot of rhododendron and apple, compared with plants mulched with ground wood pallets or growing in unmulched control plots.

The mechanisms at work are not entirely clear. The ground wood mulch kept the relatively heavy silt-loam soil wetter in the spring, which may have favored development of root rot, whereas mulching with composted yard waste increased water infiltration and drainage. Composted organic matter also supports beneficial microbes capable of out-competing and, in some cases, even killing soil borne pathogens. Fresh organic matter, on the other hand, provides a food source substantial enough to support plant pathogens as well as beneficial microorganisms. Mulching with fresh straw also increased the incidence of Phytophthora root rot of apple and raspberry in a study at Cornell University. Composted mulches eventually will lose their disease suppressive properties as the organic matter is depleted through decomposition and should be replenished every year or two.

Mulching with appropriate products also may help to prevent canker diseases by decreasing plant stress.



Figure 12

Dark spores of the shotgun fungus (*Sphaerobolus stellatus*) stick to light-colored structures and are difficult to remove.



Figure 13

The bird's nest fungus (*Cyathus striatus*).



Research has shown that many common fungal canker diseases of woody plants occur only when plants are under severe stress. By encouraging root growth and conserving moisture, mulching can lessen plant stress in drought-prone environments such as the Midwest. Therefore, mulched trees and shrubs are likely to be less canker-prone than their unmulched counterparts. An exception is in poorly drained areas where, under some conditions, mulching can lead to excessive water availability in soil. This problem can be reduced by berming soil or by installing subsurface drainage.

### Nuisance Fungi: Artillery Fungus, Bird's Nest Fungus, and Slime Molds

Mulches can also support decay fungi that can damage property and annoy property owners. The artillery fungus, *Sphaerobolus stellatus*, commonly called the shotgun fungus, discharges its spores 10 to 15 feet into the air (Figure 12). The brown to black spores stick firmly wherever they land, including on the surfaces of buildings and vehicles, where they can be conspicuous and difficult to remove. The bird's nest fungus, *Cyathus striatus*, also propels its spores but with shorter range than the artillery fungus (Figure 13). Spores can be removed by scrubbing after first wetting them thoroughly with soapy water for a few minutes to loosen their "glue." However, spore masses that have dried on building or vehicle surfaces can be difficult to remove even with vigorous scrubbing. Stinkhorn fungi, such as *Mutinus caninus* and *M. elegans*, can also colonize organic mulch and often exude an unpleasant odor attractive to flies (Figure 14).



Figure 14

A stinkhorn fungus (*Mutinus elegans*).

A recent Ohio State University Fact Sheet (available on OhioLine at <http://www.ag.ohio-state.edu/~ohioline/hyg-fact/3000/3304.html>) provides details on managing nuisance fungi in mulch. Management strategies are preventive in nature. Dry mulches (moisture content less than 34 percent) that are high in wood content cause most problems since fungi are the primary colonizers of dry wood. Moisture levels greater than 40 percent foster the growth of bacteria, which compete with nuisance fungi, reducing their potential to cause problems. However, sour mulches (discussed previously) also can generate problems since bacteria cannot survive when the pH is lower than 5.2. Most problems with nuisance fungi can be avoided by composting woody mulch before use, thoroughly soaking mulches after they have been applied, and avoiding sour mulches.

Slime molds are a group of primitive fungi that often colonize moist, decaying organic matter. Although they do not fire spores like the artillery or bird's nest fungi, some species of slime molds, such as *Fuligo*, have an appearance that some people find unappetizing (Figure 15). Slime molds can be removed by periodically raking the mulch surface or by hosing them off. Left alone, slime molds eventually dry up and disappear.

### Mulch and Nuisance Insects

Mulches provide shelter, moisture, or food for many different insects and related organisms. However, few insects found in mulch are destructive or harmful. Most mulch inhabitants are beneficial or innocuous. Presence of insects in mulch generally is not a cause for alarm or treatment but rather suggests the existence of an environment similar to natural ecosystems.

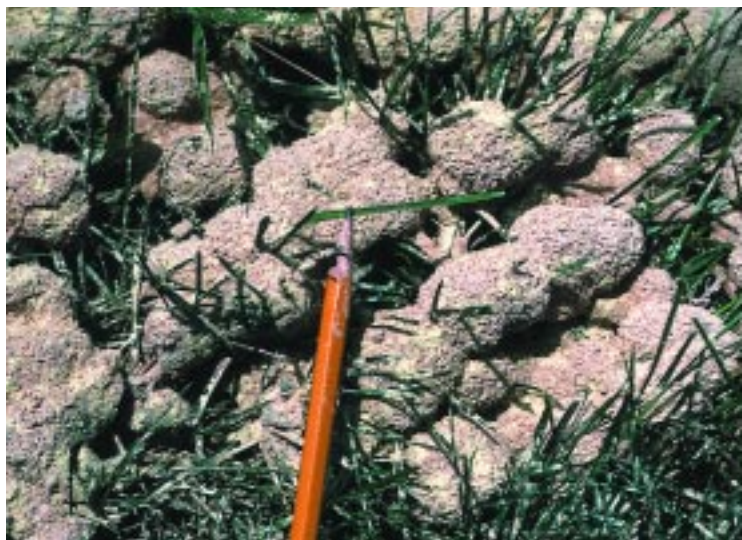
Mulch provides a stable habitat in which many beneficial organisms find a steady and reliable food source, as well as a protective shelter from desiccation, disruption, and other disturbances. Among these are important predators of insect pests, including rove beetles, ground beetles, firefly larvae, and centipedes. Other beneficial organisms are "recyclers" that feed on fungi and decaying plant debris. Their feeding or tunneling breaks down organic material and returns nutrients and humus to the soil. The decomposition of organic mulch by recyclers, such as decay fungi, ants, sowbugs, millipedes, springtails, and mites, converts the mulch into valuable organic matter that improves soil tilth.

Mulch may increase the abundance of certain plant pests by providing ideal living conditions. Examples include slugs, snails, sowbugs, and earwigs. Treatments are available for combating these plant feeders. So, eliminating mulch is not necessary. It may be advantageous to pull mulch away from the base of succulent plants.

Ants that live in the moist, loose soil under mulch are not harmful to people or structures and are generally beneficial to the soil and plants. Unfortunately, species such as the larger yellow ant, field ant, pavement ant, and odorous house ant sometimes wander indoors while foraging for food. Although these ants routinely nest in the ground under mulch, they are common around all structures whether mulch is present or not. At best, insecticides are only moderately successful at controlling ants that live under mulch.

Carpenter ants live in galleries chewed into decayed wood, such as stumps, logs, firewood, hollow

Figure 15  
A slime mold fungus (*Fuligo* sp.).



trees and dead limbs. These familiar, large, and black ants do not nest in wood chips. They may forage for food, such as dead insects, in mulch but they do not live there. Carpenter ants are best controlled by locating and treating their nest. Consult an expert.

Termites routinely feed on woody mulch and other wood products on or in the soil (lumber scraps, boards, firewood, pallets, etc.). However, there is no evidence that mulching with wood chips attracts termites that were not already present in the area, or increases the incidence of termite damage. It is also highly unlikely that termites can be spread to previously uninfested areas by the transport of wood chips.

The eastern subterranean termite is moderately common but its distribution is highly variable and uneven throughout the Midwest. Termites live in large, social colonies located underground. Worker termites tunnel to the soil surface (or higher) to feed on wood and other materials containing cellulose. Termites excavate a network of random, pencil-sized tunnels that can extend up to 300 feet from their nest as they forage for food, which is carried back to the nest and shared with other members of the colony.

Moisture plays an important role in termite foraging, favoring their exploration, tunneling, and feeding. Consequently, mulching may improve conditions for termite colonies, whether or not the termites consume the mulch. This does not mean mulch should be avoided, nor does it suggest that one type of mulch is preferable to another. Mulches that are not eaten by termites (for example, inorganic materials and wood chips from certain plant species) can still create the moist environment that may facilitate termite foraging.

## Organic Mulches: Concerns and Suggested Responses

Concern	Response
<i>Spreading plant diseases</i>	<ul style="list-style-type: none"> <li>• Keep mulch away from trunks.</li> <li>• Use composted mulches.</li> </ul>
<i>Sour mulch</i>	<ul style="list-style-type: none"> <li>• Avoid storing mulch in piles higher than 10' to 12'.</li> <li>• Store mulch in a well-drained location.</li> <li>• Turn mulch piles to aerate until sour smell disappears.</li> </ul>
<i>Rodent damage</i>	<ul style="list-style-type: none"> <li>• Keep mulch away from trunks.</li> <li>• Avoid using straw.</li> </ul>
<i>Nuisance fungi</i>	<ul style="list-style-type: none"> <li>• Use composted mulches.</li> <li>• Soak mulch after application to increase moisture content.</li> <li>• Use mineral (rock) mulch close to buildings and vehicles.</li> </ul>
<i>Slime molds</i>	<ul style="list-style-type: none"> <li>• Use composted mulches.</li> <li>• Rake mulch to break up fungus.</li> <li>• Hose off the fungus.</li> </ul>
<i>Soil oxygen depletion</i>	<ul style="list-style-type: none"> <li>• Use coarse-textured mulch.</li> <li>• Limit depth of mulch.</li> </ul>
<i>Excess moisture at base of trunk</i>	<ul style="list-style-type: none"> <li>• Maintain a mulch-free zone 6" to 12" around trunks.</li> </ul>
<i>Soil nitrogen depletion</i>	<ul style="list-style-type: none"> <li>• Use composted mulches.</li> <li>• Avoid mulches with high C:N ratios.</li> <li>• Do not incorporate mulch into soil.</li> </ul>
<i>Allergic responses to handling mulch</i>	<ul style="list-style-type: none"> <li>• Wear a pollen mask when handling mulches that have been stored for more than a few days.</li> </ul>
<i>Termites</i>	<ul style="list-style-type: none"> <li>• Keep mulch away from foundations, siding, and windowsills.</li> </ul>

Termites play a crucial role in the ecosystem as natural recyclers of wood and nutrients. Their presence inside a home or other structure, however, can lead to severe aesthetic and/or structural damage. If termites are present in your area, mulches should be inspected regularly for signs of activity. To minimize the risk of infestation, mulch should be kept several inches away from the house foundation. Mulch that covers windowsills or contacts siding may provide termites direct and undetected access into homes. If you suspect that your home is infested with termites, contact several reliable exterminators for inspections and estimates. Termite control is very complex and is best left to experienced professionals. Take your time. Do not be rushed or pressured into a hasty decision. Termites work slowly and your house will not be ruined overnight.

### Rodent Damage

Occasionally, voles and mice will damage thin-barked trees and shrubs under the mulch layer, which can provide them with shelter and protection from predators. To reduce the risk of rodent damage, keep mulch at least six inches from the trunk. Trees and shrubs can also be protected with plastic tubing, hardware cloth, chicken wire, or other suitable barriers. Straw mulches may be especially attractive to rodents because they

will feed on the seeds that often come with it. Mice and voles initially attracted by seed also may gnaw on the bark.

### Inhalation Allergies to Mulch

Thermophilic (heat-loving) microorganisms are favored by the high temperatures that occur in piles of composting mulch. When piles of composting mulch are shoveled or turned, you may notice a cloud of grayish, smoke-like material rising from the pile. This cloud is composed primarily of spores of actinomycetes and fungi, including *Penicillia* and *Aspergilli*. When these microbes are inhaled, they can produce an allergic reaction in the lungs of about 5 to 10 percent of the human population. The result can be an asthma-like condition of fluid buildup in the lungs, commonly called "farmer's lung." The allergic reaction can be mild or severe, depending on the severity of a person's allergy and the extent of exposure. But, it should be taken seriously, as some arborists have been hospitalized for severe breathing difficulties after shoveling composted chips. Whenever organic mulch is handled, it is advisable to wear a pollen mask. Pollen masks, which are light, comfortable, inexpensive, and available at most drugstores, are 100 percent effective at filtering out the spores that cause inhalation allergies.

Figure 16  
Rock mulch in a shrub border.



### What About Rock Mulches?

Several actual or perceived problems with organic mulches, such as unacceptable appearance, potential fire hazard, rapid decomposition, and their propensity to be scattered by mowers, have led to increased use of mineral or rock mulches (Figure 16). These products may have their own set of drawbacks, however. Concerns that materials such as rock, gravel, and crushed brick may heat soil enough to damage plant roots, raise soil alkalinity, or cause mechanical injury to plant stems have caused many landscape professionals to re-examine their use of these products.

Several mineral mulches were evaluated in a study at Iowa State University, including lava rock, pea gravel, crushed brick, caramel rock, and river rock. None of

the mulches tested contributed to undesirably high soil pH (although limestone, which was not tested, is suspected to be the chief culprit here). Furthermore, the capacity of crushed brick and pea gravel to conduct heat to underlying soils, particularly in the spring, may have been responsible for the increased growth of red maple mulched with these products, compared to trees mulched with shredded bark and screened pine bark. The insulating properties of the organic mulches kept the soil relatively cool during the spring.

### Summing Up

The use of mulch in managed landscapes can have many benefits. When used properly mulch can suppress weeds, conserve soil moisture, moderate soil temperature extremes, improve soil structure, increase soil fertility, and suppress some diseases. Unfortunately, improper use of mulch has been responsible for many problems in landscapes. Many of these problems can be avoided through simple precautions, such as composting fresh mulch before use and by keeping mulch away from the stems of plants and walls of buildings.

There is a great diversity of materials available for use as landscape mulch, each with differing properties that provide advantages in particular situations. Maximizing the benefits of mulch while avoiding the pitfalls requires matching the characteristics of particular mulches with plant requirements, environmental conditions, such as soil type and climate, and management objectives for the landscape. There are few general rules that apply in all situations.

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