Tree of Knowledge
Tree Care Information

Mulch:
Too Much of a Good Thing Can Be Bad

by Chris R. Carlson

Learning objectives—
The arborist will be able to

- understand the difference between organic and inorganic mulches and the advantages and disadvantages of each.
- learn how improper mulching techniques can stress and/or kill roots and inner bark (phloem) and help predispose trees to fungal and butt rots, cankers, and opportunistic insects.
- recognize the tree decline symptoms that may be associated with continued improper mulching techniques.
- know which conditions are needed for potential disease transmission via mulch.

The proper choice and application of mulch can dramatically improve the overall health and vitality of trees and other landscape plants. Improper mulching, on the other hand, can needlessly stress and potentially kill plants. Arborists should be aware of the benefits of mulch, the characterstics of various types of mulch, and the potential problems associated with overmulching.

The two basic mulch choices are inorganic and organic. Inorganic mulches such as lava rock, mineral rock and gravel, pulverized rubber, geotextile fabrics, and other materials do not decompose like organic mulches, which is why many contractors choose to use them. They do not need to be replenished often, but neither do they contribute to the organic matter in the soil. Organic mulches usually are derived from plants or plant parts. Examples include cocoa hulls, conifer needles, leaves, grass, newspaper, straw, hardwood and softwood (conifer) bark, wood chips, and other wood products. Organic mulches generally have more effect on soil structure and microbial activity than inorganics do. The fact that they decompose means that their longevity in the landscape is shorter than that of inorganics.

Even among organic mulches, longevity is variable. Wood decomposes more quickly than bark, conifers (softwoods) more quickly than hardwoods, fine mulch more quickly than coarse, succulent tissues more quickly than woody materials, and fresh tissue more quickly than dry. Conifer bark nuggets from large, mature pine, cypress, or other softwood trees contain very high amounts of lignin, wax, and protected cellulose that resist decay. Wood from these same species, however, rots quickly because the cellulose (in young trees especially) is not yet protected by the production of lignin and other materials that resist decay.

Hardwood tree bark, even from large trees, contains large amounts of cellulose that is *not* protected from rotting. Wood and hardwood bark have high carbon content and low nitrogen content (that is, high carbon to nitrogen ratios, C:N). Microorganisms that decompose wood use nitrogen in the decomposition process, which is why plants sometimes exhibit temporary nitrogen deficiencies. This phenomenon is especially noted when high wood content or hardwood bark mulches with particles smaller than 3/8 inch are incorporated into soil planted with herbaceous and woody ornamentals. Because of this nitrogen immobilization, many mulch producers screen out all mulch particles less than 3/8 inch to prevent this problem. Other producers additionally compost their mulch for a minimum of six weeks and add one to three pounds of actual nitrogen per cubic yard of mulch to speed composting and lower the carbon-to-nitrogen ratios to the ideal twenty parts carbon to one part nitrogen. This composting procedure kills plant disease pathogens and eggs of insect pests, and it produces a product that returns plant nutrients rather than ties them up.

Organic mulches have the distinct advantage of returning essential nutrients to the beneficial soil microflora upon decomposition. Because of this decomposition, however, organic mulches must be replaced periodically, and that is where many problems arise. The plague of overmulching landscape plants, sometimes to the extent of creating mountainous mulch "volcanoes," unfortunately continues because of a continued lack of education. Not only is overmulching a waste of mulch (and a potentially costly one at that), it is becoming a significant cause of death to some landscape plants.

There are many reasons why overmulched woody and herbaceous ornamentals may become stressed and die. Overmulching can

- promote excessive soil moisture and subsequent root rots
- cause inner bark tissue (phloem) death of aboveground stem flares
- cause fungal and bacterial diseases, and root, crown, and butt rots
- lead to rodent chewing on phloem tissue and subsequent stem girdling
- lead to the production of toxic organic acids (alcohols and volatile gases such as ammonia) by anaerobic microorganisms
- promote nutrient deficiencies and imbalances and possible allelopathic toxicities (allelopathy)
- lower soil temperatures during critical root growth periods, which may suppress overall root and plant growth
- prevent moisture penetration due to dry fungal masses becoming hydrophobic and actually repelling water

Lowered Soil Oxygen Levels

In addition to the problems listed above, repeated excessive applications of fine-textured mulches on poorly drained soils can contribute to poor soil aeration by slowing soil water loss through evaporation. Roots must respire (breathe) and take in oxygen. For many species, when oxygen levels in the soil drop below 10 percent, root growth declines. When too many roots decline and die, the plant eventually succumbs.

Many fine-textured organic mulches have a high water-holding capacity and can hold as much as ten to twenty times their dry weight in water. When mounds of mulch are applied over the root systems of young, shallow-rooted species, oxygen levels in the root zone can begin to decline. This phenomenon usually occurs during wet growing seasons and in spring and fall, which are the most crucial times for root growth in temperate-climate plants. This oxygen deprivation is especially prevalent on soils that do not drain well—a characteristic of many urban soils. For recently planted trees, shrubs and flowers, excessive mulch applications coupled with excessive rain or irrigation can retard or

Piling soil or mulch, or both, against the trunk flare has been shown to prevent needed gas (CO_2 and O_2) exchange, causing phloem stress, dysfunction, and subsequent root stress.

Piling mulch against the trunk flare causes tree stress symptoms that may take three to five years, or more, to be expressed. Such symptoms include small leaves, short twig growth, and narrow annual rings, to name a few.

even prevent new root growth as a result of waterlogged soil. These conditions also enhance attack by root-rot pathogens that can kill plants.

If leaves are used as mulch, they should be chopped or shredded before application to prevent matting and allow water percolation into the soil below. Likewise, if grass clippings are used alone, they should be dry and spread in a one-inch layer. Thicker layers cause matting and putrid decomposition. Avoid using grass clippings with herbicide residues that can damage tender ornamental plants.

It is most important to remember that the problems caused from yearly overmulching are not immediate but progress slowly over time. The symptoms on long-lived woody plants may take three to five years to express themselves and sometimes longer, depending on the species and soil type. Unfortunately, by the time the plant symptoms are recognized—off-color foliage (chlorosis), abnormally small leaves, poor annual twig growth, and dieback of older branches—it is generally too late to apply corrective measures. By then, the plant may have gone into an irreversible decline.

Inner Bark (Phloem) Stress

Piling mulch directly against the stems of trees and shrubs can stress them and lead to decline. Aboveground stem and trunk tissue is morphologically different from root tissues. Roots have evolved many mechanisms to survive in continually moist environments, while the trunks of most woody species have not. The aboveground stem tissue of most trees, shrubs, and perennials must be able to freely exchange adequate amounts of oxygen and carbon dioxide through their lenticels. Researchers have documented that when fine-textured mulch is piled onto stem tissue, gas exchange decreases and inner bark (phloem) tissue eventually becomes stressed.

Research scientists from the Bartlett Tree Expert Company have verified that the constant presence of moisture on trunk tissue inhibits the movement of oxygen and carbon dioxide in and out of the phloem. This restriction occurs when the aboveground trunk flare is buried with anything that holds moisture, such as fine-textured mulches or soil. When the inner bark dies, roots can become malnourished and weakened to the point where they suffer reduced water and nutrient uptake, which subsequently affects the health of the whole plant.

Fungal Diseases

Another stress factor associated with the application of mulch next to the stem tissue involves fungal and bacterial diseases. Most plant diseases require moisture to grow and reproduce and may gain entry into the stressed, decaying bark tissue caused by the piling of mulch next to stem tissue. Research has shown that collar rot caused by *Phytophthora* spp. is more likely to occur when trunk tissues are kept moist from soil, mulch, constant irrigation, or a combination of those factors. Similarly, Armillaria root rot has been observed under the trunk flares of excessively mulched woody ornamentals. Research also has shown that *Verticillium dahliae,* a common fungus causing the wilting and death of many species of ornamental trees and shrubs, can be transmitted in fresh mulch and kill susceptible plants.

Although the transmission of pathogens in fresh mulch is possible, it is rarely seen in the landscape when applied to established woody ornamentals. It appears that for woody ornamentals to become inoculated with a fungal pathogen from fresh, infected wood chips, the mulch must be directly placed adjacent to the susceptible plant, the susceptible plant usually must be injured, and environmental conditions must favor disease survival and development.

Potential disease transmission problems from infected mulch can easily be corrected by short-term composting of fresh mulches. When temperatures exceed 160˚F in the composting process for just a few days, pathogens, weed seeds, and insect eggs are killed. Turning the mulch so that all parts are exposed to these high temperatures is critical in destroying all pathogens and pests.

Other Fungal Mulch Problems

Fungal slime molds (notoriously known as “dog vomit fungus”), bird’s-nest fungus, stink horns, and mushrooms occasionally grow on organic mulches but fortunately are harmless to most ornamentals. These fungal problems usually arise in organic mulch following rainy weather. If the appearance of these fungi is offensive, they can either be removed and placed in a garbage receptacle (especially important when small children have access to mushrooms found growing on the mulch) or they can be raked into the existing mulch where they will not be so evident.

Slime molds initially appear as brightly colored (for example, orange, yellow or red) slimy masses that may be several inches to more than a foot across. These fungi do not feed on the mulch but rather “feed” on the bacteria growing on the mulch. Numerous tiny, dark spores are produced by these fungi and are wind disseminated, with the mold eventually drying out, turning brown, and sometimes leaving a white, dry powdery mass. Slime molds normally are considered a temporary nuisance.

Bird’s-nest fungi look like tiny brown or gray birds’ nests 1/4 inch in diameter and are found growing on top of the mulch. The spores, which look like eggs in the nest, are dispersed easily by rain. These fungi are natural decomposers and do not warrant removal.

Fungal slime molds tend to appear on fine-textured hardwood mulches with high carbon-to-nitrogen ratios. Although slime molds are harmless, removal or raking of the mulch, or both, usually is recommended.

A unique and interesting fungal problem is the artillery, or “shotgun,” fungus. It is caused by *Sphaerobolus* spp., and it grows on wood chips, “double-shredded” bark, leaves, and dung, and is found throughout the United States. While it decays mulch, this fungus also produces fruiting structures that resemble a tiny, cream or brownish orange cup that contains a spore mass 1/10 of an inch in diameter resembling a small black egg. Problems arise when the fungus orients itself toward bright surfaces (phototropic) and “shoots” its black, sticky spore mass droplets up to 20 feet away onto light-colored objects such as house siding, cars, and leaf undersides. Spore masses are produced between 50˚F and 68˚F and resemble specks of tar. They can be wind-blown upward as high as the second story of a house. Once settled, they are extremely difficult to remove and leave stained surfaces. Unfortunately, many insurance companies will not cover damage claims due to “molds.” Because chemical controls (fungicides) are ineffective, control solutions involve prevention and avoidance.

Hydrophobic mulches can be produced when mulches are matted or applied too deeply. This condition commonly occurs when fresh, woody mulches (especially shredded cypress bark) are used during the summer. The mulch can dry out to less than the critical 34 percent moisture content. Fungi may then colonize these dry, dusty mulches, causing them to become water repellent (hydrophobic). Under such condi-

tions, newly transplanted trees may die from drought—even though the homeowner or landscaper irrigates the plants—because the water runs off the top of the mulch. The situation can be easily remedied by simply raking the mulch and breaking up any of the crusted, hydrophobic layers.

Secondary Opportunistic Borers

In addition to the potential for disease problems, insect borers and bark beetles have been associated with stressed, over-mulched trees and shrubs. Many borers are attracted to stressed plants. Once established, borers and bark beetles tunnel through sapwood, weakening the plant structurally and functionally. Proper mulch placement (away from the trunk) and depth (two to four inches thick) help prevent these problems and help invigorate the plant so that it can naturally repel these pests.

Mulch pH Problems

The continual use of certain types of mulch may cause changes to the surface soil's pH. Acidic mulches such as pine bark and peat moss may have a pH of 3.5 to 4.5, and when used year after year, may cause the surface soil to become too acidic to grow many plants that require a high pH (alkaline). Alkaline-loving plants simply won't thrive because of the increased solubility and availability (and potential toxicity) of many micronutrients such as iron, manganese, and zinc. Hence, toxic levels of micronutrients may lead to additional plant stress, which in turn gives secondary pathogens and insects the chance to successfully invade. Many times, the symptoms of micronutrient toxicities mimic Phytophthora root-rot symptoms. Soil and tissue tests usually help verify the cause of the problem. Acidic pine needles have proved beneficial in maintaining the acidic conditions required for many ericaceous plants such as rhododendrons and azaleas and appear to help control several harmful soil fungi, including *Fusarium*.

Inorganic mulches also should be tested for pH before being applied around plants. Limestone gravel used as mulch can stress acid-loving plants. Many research studies have shown that mulches do not significantly alter subsurface soil pH because of the buffering capacity of the soil. Changes in surface-soil acidity, however, can be attained by using mulches.

Chewing and Girdling Caused by Rodents

Piling mulch adjacent to tree trunks and other landscape plantings can cause indirect damage to plants by providing hiding cover and habitat for chewing rodents such as mice, meadow voles, and similar animals. Rodents usually live under the warm mulch in the winter and chew on the tender and nutritious inner bark to get at the sugars. This chewing off of the bark many times goes unnoticed until the following spring or summer when the homeowner notices "the tree doesn't look good." If the chewing is extensive (usually more than 50 percent of the circumference is girdled), little can be done to save the tree.

Anaerobic "Sour" Mulch

Sour mulch generally is produced when finely ground mulch is piled so high (usually greater than 10 feet) that inadequate air exchange occurs in the center of the pile. Without adequate oxygen, anaerobic microorganisms produce several organic acids and alcohols, causing mulch to give off acrid, pungent odors and produce pH levels ranging from 1.9 to 4.8. This mulch is highly toxic to plants and may kill tender annual and perennial herbaceous ornamentals and recently transplanted woody ornamentals. If mulch smells bad or is extremely acidic, avoid using it until it is properly composted—with adequate aeration (weekly turning), adequate moisture content higher than 40 percent on a total weight basis, and nitrogen applications.

Although prudent use of mulch is one of the most beneficial things an arborist or home owner can do for trees, arborists must be aware of the problems that can be associated with mulch—particularly with overmulching. As "mulch volcanoes" become the plague of the modern landscape, it is more important than ever to help educate landscape maintenance providers about the perils of this practice.

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Chris R. Carlson is director, horticulture technology, and associate professor at Kent State University, Salem Campus, Salem, Ohio.