JOURNAL OF THE NACAA

ISSN 2158-9429

VOLUME 15, ISSUE 2 – DECEMBER, 2022

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Garden Myth-Busting for Extension Educators:

The Science Behind the Use of Arborist Wood Chips as Landscape Mulches

Abstract

The current trajectory of climate change suggests that summer temperatures will rise, and drought conditions worsen in many parts of the world. Mulches can reduce soil water loss in gardens and landscapes. Not all mulches are created equal, however, and some mulches can damage both soil and plant health. This literature review will focus on arborist wood chip (AWC) mulches – arguably the most beneficial landscape mulch – and address common misconceptions about this mulch material. We also provide science-based recommendations for using AWC mulches to enhance the resiliency of managed landscapes.

Introduction

In this literature review, we differentiate between mulches and soil amendments in that soil amendments are worked into the soil. By comparison, a mulch is any material that covers bare soil. While it is obvious that some soil coverings (e.g., uncomposted organic

material) are undoubtedly more beneficial to plant and soil life than others (e.g., asphalt, rock, or plastic), there are some similarities among all mulches:

- Reduced soil erosion and compaction
- Moderated soil temperatures (i.e., mulched soils are warmer in the winter and cooler in the summer than unmulched soils)
- Reduced weed cover
- Reduced pesticide use

Some mulches, particularly organic mulches, have additional benefits, including:

- Improved soil moisture
- Increased soil nutrition
- Reduced salt and pesticide contamination
- Increased binding of heavy metals
- Improved plant establishment and growth
- Reduced incidence of disease
- Improved aesthetics
- Improved economic value

The purposes of this literature review article are:

- to categorize different landscape mulches and briefly compare their benefits and drawbacks;
- to identify some common misconceptions that homeowners and landscape professionals have regarding wood chip mulches;
- to provide a brief, science-based explanation clarifying and correcting each of these misconceptions; and
- to provide science-based recommendations for selecting, applying, and managing landscape mulch materials.

A Comparison of Landscape Mulches

Choosing a landscape mulch at a garden center or hardware store can be confusing for homeowners; packaging will highlight benefits but not the drawbacks of the product. Below we briefly describe landscape mulch categories, comparing their relative benefits and drawbacks (also displayed in Table 1). A more detailed comparison can be found elsewhere (Chalker-Scott, 2007).

Table 1. Impacts of landscape mulches compared to bare urban soils.

	Living	**Synthetic**	**Inorganic**	**Organic**
Soil moisture	+/0/-	-	+	+
Compaction reduction	+	+/0	+	+
Temperature moderation	+	+/0/-	+/0/-	+
Nutrients	+/-	-	0	+/0
Plant growth enhanced	+/0/-	0/-	+	+
Soil life enhanced	+	-	+	+
Weed control	+	-	+/-	+
Pest insect control	+/0	0/-	+/0	+/0
Disease control	+/0	0/-	+/0	+/0
Pesticide use reduction	+	-	+/-	+
Cost	$	$$ to $$$	$ to $$$	0 to $$
Availability	N/LC	N/LC, HI	N/LC, HI	N/LC, HI, A/U/TS
Ease of replacement	Moderate	Difficult	Easy	Easy

Key to symbols:

+ = positive impact
0 = no net impact
- = negative impact

$ = low
$$ = moderate
$$$ = high

N/LC = nursery/landscape center
HI = home improvement store
A/U/TS = arborist/utilities/tree service

Living mulches

Living mulches are simply groundcovers (Figure 1). These include cover crops (commonly used in sustainable agriculture) and ornamental groundcovers. Homeowners are most familiar with lawns, but mosses and many short-statured flowering plants (e.g., *Dymondia margaretae* [silver carpet]) can serve as functional and attractive living mulches. While groundcovers provide many of the benefits associated with mulches, they do compete with other landscape plants for water, nutrients, sunlight, and space. Where any of these resources are limited – especially water – nonliving mulches are a better choice.

Figure 1. Examples of a sun-tolerant (left) and shade tolerant (right) groundcover, also known as living mulch. Photos by Linda Chalker-Scott.

Synthetic mulches

As their name suggests, synthetic mulches are not made of natural materials. While they may have a longer life in the landscape, there are drawbacks associated with synthetic materials. For instance, recycled rubber mats and chips certainly do not break down as quickly as those made from natural materials, but they do decompose and during that process release chemical contaminants that should be avoided (Chalker-Scott, 2021). Moreover, they smell strongly of rubber and can be uncomfortably hot during the warmer months. We do not recommend their use in any landscape setting.

Other synthetic mulches, such as landscape fabric (also known as geotextiles) and black plastic are poor choices because their two-dimensional nature reduces water and gas movement between the soil and the atmosphere. In fact, a single sheet of landscape fabric or black plastic reduce gas movement by factors of 100 and 1000, respectively, compared to 4" of arborist wood chips (Figure 2; Shahzad et al., 2019). Though sheet mulches can reduce erosion, there are few other benefits to landscape soils. We do not recommend any sheet mulches for use in landscapes as the reductions to gas and water movement have negative effects on plants and soil organisms.

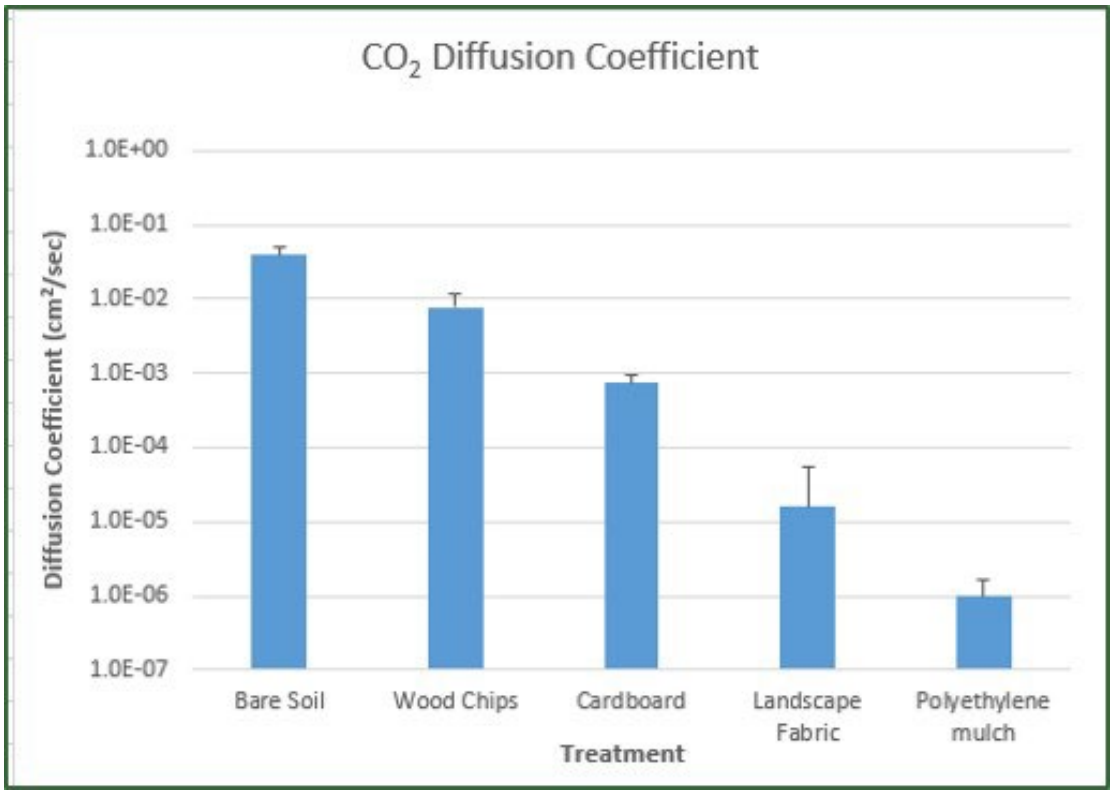

Figure 2. Comparative CO_2 diffusion coefficients for different mulch materials. Derived by Linda Chalker-Scott from data in Shahzad et al., 2019.

Inorganic mulches

Inorganic mulches encompass both unprocessed materials (various sizes and types of stone) and manufactured and recycled materials (such as tumbled glass and concrete pavers; Figure 3). These are the most resilient of mulches, as they weather slowly and don't require frequent replacement. Contrary to popular opinion, stone mulches do not

heat the underlying soil and they do provide several benefits. While deep layers of stone mulch will initially prevent weed establishment, this is not a permanent benefit as seeds and soil blow in and settle among the stones, leading to weed populations that can be very difficult to control without herbicide use.

Figure 3. Examples of different inorganic mulch materials. Photos by Linda Chalker-Scott.

Organic mulches

Organic mulches encompass a broad collection of unprocessed and processed materials that will all decompose. While this characteristic means that organic mulches must be replaced, this drawback is far outweighed by the relative benefits. There are some organic mulches that should be avoided, however, for some of the reasons discussed earlier. Cardboard and newspaper, for instance, are sheet mulches and interfere with water and oxygen movement into the soil. Likewise, finely textured mulches such as compost and sawdust cannot be applied in deep layers as they too will limit gas and water exchange. Deep layers of coarse organic mulches both restrict weed establishment and enhance the establishment and growth of desirable landscape plants

without limiting gas exchange (Cahill et al., 2005). Some coarse organic mulches (such as bark mulches and nutshells) do not readily absorb water, are easily dislodged, and are slow to break down. Because they are hydrophobic, they provide few nutritional benefits. In comparison, wood chip mulches do absorb water and support a robust population of beneficial microbes, particularly mycorrhizal and other saprophytic fungi.

There are wood chip mulches (e.g., hog fuel and playground chips) available at garden centers and other retail sites. But the landscape plant and soil research to date overwhelmingly suggest that arborist wood chip (AWC) mulches provide more benefits and fewer drawbacks than any of the other mulch choices (Chalker-Scott, 2007). Arborist wood chips are available from tree services, where tree prunings and removals are immediately fed through the chipper (Figure 4). Unfortunately, homeowners and professionals are often reluctant to use AWC mulches because of perceived drawbacks, none of which are supported by research. We deconstruct five misconceptions below.

Figure 4. Arborist wood chips delivery from a local tree service. Photo by Linda Chalker-Scott.

Arborist Wood Chip Mulch Myths

In a previous myth-busting article (Chalker-Scott and Downer, 2018) we addressed two common myths about wood chip mulches, namely that wood chip mulches cause soil nitrogen deficiencies and will spread disease to healthy plants. Since publication of that article, there is no recent science to challenge our interpretation and recommendations regarding wood chip mulches. Our current article focuses on five additional misperceptions commonly voiced by homeowners and landscape professions.

Myth 1: "Woody mulches will acidify the soil"

Wood is naturally acidic, as it contains organic acids. During decomposition, these acids are released into the environment. If one were to test the pH of a composting wood chip pile, the values would definitely be in the acidic range. But a wood chip mulch on top of a landscape soil is not going to change the pH of the soil itself (Iqbal et al., 2020; Melgar et al., 2021). The sheer volume of soil in a landscape, along with its ability to buffer acid or alkaline additives, means that most soil pH levels remain constant.

Myth 2: "Deep mulches injure plants" (including volcano mulching)

As discussed earlier, sheet mulches and finely textured mulches will both interfere with water and oxygen movement into the soil. By contrast, coarse organic mulches, such as AWC, do not interfere with water and gas exchange. Their chunky nature allows both water and air to pass through easily. One needs only to observe natural forests to understand that they produce their own mulch layer as a result of leaf and branch fall along with other organic debris.

Deciduous forests can prove the exception to this observation: dense leaf fall can create wet mats of leaves, which do reduce oxygen movement into the soil and create temporary anaerobic conditions during the winter (Figure 5). Once the leaves have sufficiently decomposed and plant growth and animal movement have disrupted the barrier, soil oxygenation recovers. The impact of these natural sheet mulches on soil oxygen levels provides yet another caution against using them in a managed landscape.

Figure 5. Thick, matted layers of decomposing leaves will restrict air flow between the soil and the atmosphere. Photo courtesy of Public Domain Pictures.

Arborist wood chips, on the other hand, cannot form impermeable mats and their use as a mulch has never been associated with plant injury or death. As discussed in our earlier article (Chalker-Scott and Downer, 2018), AWC are not carriers of pathogens and will not cause disease (Figure 6), even if they are made from diseased trees. Instead, they serve as habitat and a carbon or food source for myriad beneficial fauna and microbial flora (Stefani et al., 2022). Beneficial microbes can cover mulch particles and root and trunk surfaces, making them less likely to be colonized by pathogenic species.

Figure 6. Research on buried inoculum studies shows that pathogens are poor survivors in fresh wood chip mulches or yard wastes. Photo by Jim Downer.

Unfortunately, the concurrence of “mulch volcanoes” with dead and dying trees has led many homeowners as well as professionals to assume a causal relationship: in other words, mulch volcanos are causing tree death. While it’s true that poorly chosen mulches as discussed earlier can create low oxygen conditions that are conducive to disease, AWC do not do this. In fact, research has demonstrated that tree trunks deliberately wounded and then covered with AWC do as well, if not better, than those wounded trees left uncovered (Giblin, 2021; Figure 7). There has been no research to show any linkage between deep layers of AWC and plant damage.

Figure 7. Wounded maple trees (left) were covered with AWC mulch (center) or left exposed (right). Wound closure was generally enhanced when covered with arborist wood chips. Photos courtesy of Jeff Gillman.

Myth 3: "Woody mulches attract pests"

While plants contain many volatile compounds that are released upon chipping, these chemicals rapidly dissipate into the atmosphere or leach into the underlying soil and thus provide little chemical attractiveness to pests. Pests do not survive well in AWC (Chalker-Scott, 2015; Crohn et al., 2007; Daugovish, 2007; Downer et al., 2008). Since AWC are composed of active undecomposed carbon they fuel rapid microbial growth that outcompetes most pathogens. Weed seeds do not grow well in AWC because the chips hold little free water and thus seed germination is inhibited and viability reduced. Furthermore, the germination of photodormant seeds and growth of root crowns of perennial weeds beneath deep layers of AWC are inhibited by the lack of light (Figures 8-9). While insects can survive in chips, especially in pupal stages, chipping significantly reduces the viability of many pest species, such as shot hole borers in infested green wastes (Eatough-Jones and Paine, 2015).

Figure 8. Freshly installed wood chip mulches at different depths during field research. Photo courtesy of Eric Eulenberg.

Figure 9. One year after mulch installation, weeds have covered the area except where wood chips are the deepest (8-12 inches). Photo courtesy of Eric Eulenberg.

Myth 4: “Wood chip mulches are flammable”

While public fire agencies often advise against wood chip mulches, there is little research-based evidence to support this caution and good evidence to suggest they are relatively inflammable. Since AWC can absorb and hold moisture in irrigated landscapes, their flammability is greatly reduced. AWC are also rapidly invaded and decomposed by fungi, which are mostly composed of water and are not in themselves flammable. Composted wood chips will be well-inoculated with fungi as a function of the composting process, as will fresh AWC soon after their application to the soil. Quarles and Smith (2011) found that mulch materials varied in their flammability: western red cedar bark chips were the most flammable, while composted mixed wood chips only smoldered when tested (Figure 10). Likewise, conifer chips are generally more flammable than hardwood chips (Ganteaume et al., 2009). Flammability could be attributed to the waxes found in bark, and this is a good reason to avoid bark mulches.

Figure 10. Contrary to popular belief, AWC do not easily burn even when subjected to direct flames. Charring is the only result. Photos by Jim Downer.

Grasses are more flammable than woody mulches and as the moisture content of mulches goes up the flammability rapidly decreases. The grass-retarding impacts of fresh wood chip mulches may be more valuable in reducing flammability of landscapes than the risk of using AWC, especially if the landscape is irrigated.

Myth 5: "Jumping worms eat wood chip mulches"

One of the newest (and most puzzling) myths we've come across is that jumping worms (*Amynthas* spp.), introduced from Asia, eat wood chip mulches (e.g., Gupta, 2021) and can be transported in freshly cut arborist wood chips. Regardless of where worms come from, they share the same general physiology and morphology. Worms do not have teeth, nor can they ingest large pieces of wood. Jumping worms (Figure 11), like any other worms, feed on small particles of decomposed organic material. Their presence in newly produced AWC (which is anecdotal at best) is a correlative phenomenon that should not be elevated to a causal one.

Figure 11. *Amynthas* species are easy to distinguish from other earthworms, but the diets of all worms are similar. Photo courtesy of Cornell Cooperative Extension.

A Summary of the Benefits of Arborist Wood Chip Mulches

By nearly every measure, arborist wood chips benefit soils and plants. While these benefits have been described elsewhere (Chalker-Scott, 2017, 2015, 2007), they are worth summarizing here:

- Retain water, reduce runoff and evaporative loss (reducing irrigation time)
- Reduce compaction
- Moderate soil temperatures
- Provide a slow feed of macro- and micronutrients as they decompose
- Increase root formation under mulches, enhancing plant establishment and growth
- Provide habitat and a carbon source for mycorrhizal fungi and other beneficial microbes
- Reduce the likelihood of disease organisms to become virulent, especially root pathogens
- Provide habitat for beneficial arthropods which can help manage pests
- Suppress weeds
- Reduce pesticide and fertilizer use

Science-based uses of AWC

- Apply mulches at least 4 inches thick to derive maximum mulch benefits
- Reapply fresh mulch at least once per year, or as depth decreases below 4 inches
- If possible, use freshly chipped AWC for maximal benefits
- Do not use weed barriers or landscape fabrics under AWC; they interfere with soil and root health (Chalker-Scott, 2007)
- Do not apply fertilizers over or under mulches without a soil test. Only established deficiencies should be addressed through fertilizer application.

Finally, AWC are usually easy to find, are relatively inexpensive, and can easily be replaced. With our climate in North America becoming hotter and drier, these mulches can help protect landscapes and gardens from drought and heat damage.

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