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## Compost:

### In the Bin, the Garden, and the Environment

By Kate Gardner

When I started composting several years ago, I was like a lot of gardeners: I knew that compost was good for my garden, but I had no idea why.

As I began research for this article, my questions merely multiplied. Some of the claims made about compost seemed too good to be true and others made no sense at all. How could compost fight plant diseases? What did it mean to say, as so many sources do, that compost "buffered" or "balanced" soil pH levels? If compost did bind nutrients in the soil, how did it do so? Lots of sources list "adds beneficial micro-organisms" under compost benefits; did it really do this, and if so, what are the benefits?



And then there were the practical questions. Many sources said to layer ingredients for a pile -- why? What was the simplest bin for the manually un-dexterous (me) that would still look good? Was there any way to get out of turning a pile? (If so, I wanted to know about it.) What advantage was there to hot composting, other than speed? Some sources said a hot pile would kill weed seeds; others said to keep weed seeds out of the pile. How hot, then, did a pile have to be, and for how long, in order to kill seeds? What about pathogens? Oh, and was it possible to add too much compost to soil?

In writing this article, therefore, I wanted to cover the nuts and bolts of composting as thoroughly as possible, but I also wanted to answer those questions about how compost does what it does, which meant delving into compost physics, chemistry, biology, and soil science. For those who share my insatiable curiosity, I've included most of the scientific information I came across, but in deference to those who want to get started on a pile without wading through all kinds of background information, the science is largely confined to its own sections.

As it turns out, all those claims about what [garden compost](#) can achieve are true. Compost suppresses soil-borne diseases? True. Compost prevents nutrients from leaching out of soil? Also true. So are the claims about beneficial micro-organisms, for which I feel a new and probably unrequited affection. And the claims about "balancing" soil pH, which turns out to mean that compost will help raise pH if it's low and lower it if it's high. Not to mention the claims that it improves water retention in sandy soil and water drainage in clay soils.

And that's just the start.

#### About Sources:

For scientific questions, it's my policy to site government and university sources as often as possible rather than popular ones.

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How is it possible for one substance, compost, to do all the things it's credited with doing? On the one hand it boosts plant health, improves soil structure, and contains microbes that produce antibiotics. On the other hand, it promotes chemical activity in the soil that converts nutrients to plant-friendly forms, keeps them from leaching out of the soil, and nourishes fungi that ferry nutrients from deep in the earth to plant roots. On the third hand (and already we're in trouble here), composting prevents both air and water pollution, while compost itself breaks down some toxic chemicals, immobilize others, and removes still others from polluted soil. On the fourth hand, it performs two pairs of seemingly impossible feats: it raises pH in acidic soils and lowers it in alkaline soils, and it improves water retention in sandy soils and drainage in clay soils. How, how is all of this possible?

The answer lies in compost's complexity, which makes it marvelously adaptable. It contains so many elements and compounds, in so many combinations, and it supports such a rich, diverse, panoply of organisms, both micro- and macro-, that there's always something there to meet the need of the moment: to make nutrients available to plants, to chemically degrade a dangerous pollutant, to expand like a sponge in sandy soils, or to pull together little clumps of clay colloids so that there's room for water to trickle down between them.

Beyond that single overarching attribute, three secondary attributes -- one chemical, one biological, and one physical -- explain most of compost's effects.

**First, the chemical attribute:** Compost provides an extraordinary number of attachment points for charged particles -- places where other molecules and compounds can latch on. This explains its ability to both lower and raise pH ("balancing" it) as well as its ability to shield soil from sudden changes in pH (the "buffering" effect.) It also explains why compost can help bind nutrients (by providing places to which the nutrients can chemically attach) and that, in turn, explains how it can prevent water pollution: by preventing nutrients from *leaching* or being washed out of the soil and into ground or surface water.

This same attribute explains how compost can "bind" some toxins in the soil, thus preventing them from being taken up by crops, which might otherwise become too poisonous to eat.

**Second, the biological attribute:** Compost itself contains vast quantities of organisms, and it also provides the foodstuff that nourishes those already in the soil. The larger organisms -- beetles, worms, earwigs, centipedes -- help aerate and mix dirt as they move through it, and of course worms, which feed on organic matter, produce the very highest quality compost through their castings.

The sheer variety of micro-organisms means that there's almost always something in there that can "eat" -- and in the process, degrade, or break down -- almost anything, including various toxic chemicals. Some soil bacteria produce antibiotics (many of our antibiotics originally came from soil) so it is in fact not so surprising that they help protect plants against various soil-borne diseases. Many of these micro-organisms help convert nutrients into forms plants can absorb.

**Finally, the physical attribute:** Compost improves soil structure. In brief, this means that it helps form aggregates, or little clumps of matter, in soil. This extremely simple fact has huge ramifications. When molecules move together to form aggregates, spaces open up between them, so the soil gains loft and porosity. Aggregates rich in organic matter are extraordinarily absorbent, so in sandy soils improving structure helps retain water. In clay soils, the pores that open between aggregates allow air, water, earthworms, and roots to move freely. As a result, the many soil organisms and chemical processes requiring oxygen can get it, water can get out, and plants can develop deep root structures, accessing nutrients from a large volume of soil.

As is already clear, these attributes interact and overlap. Micro-organisms transform soil constituents chemically, and both they and some larger soil organisms produce mucus which promotes aggregation. Improved structure in clay soils facilitates chemical reactions requiring oxygen or atmospheric nitrogen; in sandy soils it promotes those (including the dissolving of nutrients and their absorption by plant roots) that require water. Good soil structure also provides the environment that supports a rich soil life. And so it goes.

## Why Bother Building Piles?

Alchemists, seeking to turn lead into gold, may have been doomed to perpetual disappointment, but composters will always succeed in the end because decay is inevitable. Composting, too, "happens." Any pile of plant debris will eventually decay, or compost; it's only a question of time.

Given that fact, why bother with "building" a pile? Why not just let nature take its course? In fact, that's exactly what some people do. They toss everything on a pile. That's all. Some pull finished compost from the bottom; some start another pile while the first one slowly decays. In most regions (deserts excepted), compost does not have to be turned and tended, nor does it require a specially designated site; it can be set up on the garden itself.

But sometimes things go wrong. Animals or birds can discover such a heap, and if your backyard pile becomes a collecting site for coyotes or raccoons, or even for crows or magpies, you've got a problem that ranges somewhere between serious and nuisance levels. Piles can suddenly start to smell, which does not make them (or their owners) popular in the neighborhood.

Precisely because composting is so "natural," it's especially frustrating when one's pile doesn't behave -- won't heat up, or smells, or appears simply to resist that "inevitable" process. How do these things happen?

It helps to remember that Nature doesn't pile all her refuse in a contained area, so compost heaps only distantly resemble natural composting conditions. Where organic refuse does mount up three or four feet deep behind a downed log along a riverbank, animals may raid it or it may smell, just as a backyard pile might. But what's fine out in the wilderness can be a problem in your backyard.

Then there's the question of time, an issue that seems to worry humans far more than it does nature. Completely natural, unassisted decay can take several years, while some [compost tumblers](#) can produce usable material in a matter of weeks. For reasons that range from lack of space to simple impatience, the "let it happen" approach won't work for everyone.

Speed is not the only advantage to a more carefully controlled process. All decomposing microbes produce heat as a by-product of metabolism, as do we. A "hot" compost pile, one built and maintained to augment that heat, can reach temperatures over 140°F (60°C), high enough to kill weed seeds, while an unassisted version will not. Even more important, hot composting will also kill pathogens, both plant and human. [E. coli and salmonella](#), which can enter your pile through several routes, will both be killed by temperatures over 131°F (55°C) if they're sustained over several days, and few "laissez-faire" heaps reach these temperatures. But even the low-burn, no-turn compost heaps tend to do better -- decompose faster, avoid odors, repel animals -- if they are constructed with some care.

## Many Roads to the Same Destination

Most composting information available today pushes the speedy method, achieved with a hot pile in an enclosed bin. Indeed, some books and websites might give you the impression that composting is actually a race, and only speed counts.

Don't believe it. If the fast method doesn't suit you or your garden, stand fast. There are far more composting methods out there than you might think. It's rather like Dr. Seuss's green eggs and ham: You can compost in a bin, Just snip things off and toss them in, Or you can compost in a row, right next door to where you sow; you can compost hot and fast, or slow and cool and built to last. You can compost here or there, you can compost anywhere!

You get the idea. You can build a pile above ground or below, with a container or without. You can turn it twice a week or not at all; you can build it on the garden, under the garden, beside the garden. You could probably compost on your roof, if you were determined enough.

You can even compost inside, in more than one way. All of these methods are discussed in some (if not exhaustive) detail on the page on [Indoor Composting Methods](#).

If you want to compost, there's a way to do it that will fit you, your garden, and yes, your lifestyle.

### What's on the Composter Connection

This site may well provide Too Much Information, especially for a beginner. Rest easy. You don't need to know about [actinomyces](#) to build a successful compost pile, (though it's good for showing off at parties). If you want to get a pile underway with the minimum of background reading, stick to the how-to sections.

Knowing that a smelly pile may need more oxygen and that anaerobic compost may harm plants is better than a party trick. Knowing these things could save your compost pile -- or your garden -- so they're covered in the practical pages.

If you find yourself sneezing whenever you turn your pile, or if you're wondering how to deal with heavy metals or pesticides in compost, see [A Few Composting Concerns](#), which covers the rare instances in which compost can actually harm us.

It may pique your interest to learn that compost makes nutrients accessible by increasing the number of places where these minerals can latch onto soil particles (see [Boosts Cation Exchange Capacity \(CEC\)](#)), or that some of the bacteria it nourishes produce antibiotics, which is why it helps fight soil-borne diseases. That sort of information can be found in [Composting Science](#), on what happens in the pile itself, and in [Soil Science](#), on what happens when compost is added to soil.

The environmental impacts of composting -- and not composting -- are discussed in some detail in [Environmental Issues](#). If you want to know how much garbage we could compost but don't, or how compost helps plants remove arsenic from contaminated soil, you'll find it there.

That sort of information is available here for the curious, but you don't need it to produce first-rate compost.

### Benefits of Compost to Your Garden

- improves soil structure in all soils, and therefore
- improves water retention in loose, sandy soils;
- improves drainage in heavy, clayey soils;
- prevents the soil surface from crusting, easing the emergence of seedlings;
- resists compaction, making it easier for roots to penetrate the soil;
- helps balance pH, making alkaline soils more acidic and acidic soils more alkaline;
- provides a good environment for the microbes, earthworms, and insects that break down soil constituents into plant nutrients;
- nourishes microbes that protect against some plant diseases;
- reduces the need for other soil amendments and for fertilizer;
- provides many micro-nutrients and low levels of macronutrients;
- raises the cation exchange capacity (CEC) of soil, which means that it also
- improves the soil's retention of nutrients, thus increasing the amount of time they are available to plants;
- slows the leaching of nutrients, thus preventing them from reaching and polluting water;
- encourages healthy plants, thus reducing the need for pesticides and fungicides.

### Benefits to the Environment

- reduces the amount of garbage in landfills, and therefore
- reduces the greenhouse gases produced by hauling garbage;
- reduces the amount of methane produced by landfills;
- helps prevent runoff and soil erosion;
- helps remediate (decontaminate) polluted soils, binding some contaminants in the

soil and increasing plant uptake by others, allowing their removal from contaminated sites;

- reduces the need for environmentally damaging pesticides and fertilizers.

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