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As a consulting arborist, I was once asked to examine the surface roots of a large tree on the property of a client. He wanted to plant a perennial bed around the base of the tree but was having trouble because the tree's roots were close to the soil surface. He sought my opinion on whether he could clear away some of the surface roots with an axe.

My response was that if he did that, he might as well just cut the tree down. Cutting into the root system that extensively, I explained, would in all likelihood kill the tree and require its eventual removal as it was located in close proximity to his house.

Instead, we accommodated his wish by designing a garden bed that was simply a layer of mulch placed between visible surface roots in a wagon wheel formation around the tree. The

A sea of bluebells thrives in Winterthur Garden in Delaware. The homeowner then planted the bed with native groundcovers and perennials, thus avoiding damage to the tree roots.

A desire to create new beds under and around existing trees is very common among gardeners. Often this allows several trees to be brought together in a single bed, reducing the area of lawn to be mowed and fed. Sometimes it reflects a wish to replace turf grass struggling to become established in dry shade with something more attractive and easier to care for.

Understanding the physiology of tree roots before you launch into a project like this will increase your chances of sustaining a tree's health. Because trees—especially mature ones—are a valuable investment, you must carefully consider what you plant around your trees and how you plant it. The closer your garden to an existing tree trunk, the greater the potential there is for root damage.

The Root of the Issue

According to Scott Josiah, an extension forester with the University of

PLANTING UNDER TREES

Protecting tree roots from damage is important when creating beds under trees. **By David Oettinger**

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Nebraska, the leading cause of tree death during landscape construction is damage to roots. Such damage is usually the result of digging or grading within the “critical root zone” of a tree, which is defined as the area in which the loss, disturbance, or damage to any roots will adversely affect the tree’s long-term health and structural stability.

This kind of root damage may not directly kill your tree. More often, to make up for the lack of nutrient uptake, the tree

Wood hyacinths (*Endymion hispanicus*) grow beneath the autumn foliage of the European beech tree (*Fagus sylvatica*), above. Hostas, below, flourish in shady areas with cool, moist, well-drained soil.

begins to divert resources from defense to growth. This leaves it vulnerable to secondary stresses such as disease and insects. It is this secondary attack that usually kills the tree—sometimes months or even years later.



Chemical Defenses

A FEW TREE SPECIES are allelopathic—they produce chemicals that can kill or inhibit the growth of other plants growing underneath or nearby. The best-known example of this is walnuts (*Juglans* spp.), which produce juglone, a chemical toxic to a wide range of plants including azaleas, blueberries, and tomatoes. Other trees known to have allelopathic tendencies are sugar maple (*Acer saccharum*), black locust (*Robinia pseudoacacia*), cherries (*Prunus* spp.), hackberries (*Celtis* spp.), some eucalyptus (*Eucalyptus* spp.), and sassafras (*Sassafras albidum*). So be aware that it may be harder to establish new plants under these trees than with some others.



Gardeners naturally tend to fixate on the health of the visible, aboveground structure of the tree. It's easy to forget about the roots, which serve several key functions—anchorage, absorption of water and mineral nutrients, storage of food, and synthesis of certain organic materials, including those that regulate activities in the top of the plant.

Roots, unlike stems, do not have regular branching patterns. They grow wherever moisture and oxygen are available. Paul Cowie, a consulting arborist in New Jersey, says there's a common misconception that roots do not grow beyond a tree's crown—the circumference of the branch spread. He notes that under ideal growing conditions, a tree's root system can extend up to two to three times the width of the crown. "Roots won't stop at the drip line unless a physical or environmental barrier prevents them from growing beyond it," says Cowie.

Tree roots are easily damaged. The roots of most ornamental trees, for example, grow in the first one to two feet of soil. And most of the fine roots—the ones that absorb water and nutrients—are located in the upper foot.

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Of course, some trees do send roots deeper than others. Roots are opportunistic, and root depth is as much soil dependent as species dependent. According to Cowie, even typically deep-rooted species may become surface rooted when growing in compacted soil or above a hard pan or rock outcrop.

"The important thing for gardeners to understand," says Cowie, "is that some tree species produce a denser root mass that is more difficult to work around. Maples for example, produce a thick, dense mat of fibrous roots, while oaks tend to have

Species of *Melaleuca*, *Pentas*, *Liriope*, *Scaevola*, and *Pelargonium* are shown growing at left. Narcissus and daffodils do well under deciduous trees like the *Betula nigra*, below.





larger, more distinct primary horizontal roots that can be located and worked around.”

Severely compacting the soil around a tree—which often happens when heavy equipment is used during construction or major landscaping—can also jeopardize tree health because compacting soil removes air that roots need

***Equisetum*, commonly called horsetail or scouring rush, swells beneath the *Alnus*, left. *Hedera helix* (common ivy) and *Nerium oleander* (evergreen shrub) line a path in Rancho Los Alamitos, California, opposite.**

Cut with Care

The rule of thumb among arborists is that once 50 percent of a tree’s root mass is lost, the eventual death of the tree is a foregone conclusion. Extensive root loss also makes a tree

for healthy growth. If you are planning major construction for your home or garden, ask the contractors to make the root zones of trees off limits to heavy equipment by roping them off or installing temporary fencing.

Perhaps the biggest dilemma in trying to plant under trees is the same problem my client encountered—finding space to plant without damaging roots. Attempting to dig through a series of roots will test the patience of any gardener and will induce considerable stress on the tree.

The other main option is to add soil for new beds around the base of a tree, but unless this is done carefully, it can also increase the likelihood of root loss over time.



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very unstable, which can create a hazardous situation.

Of course, the fewer roots removed, the better. According to the International Society of Arboriculture, severing even one major root can cause the loss of 15 to 25 percent of the root system. And root damage does not repair quickly. On average, it takes a tree one year for every inch in trunk diameter to recover

from torn roots. If you must trim roots radically to accommodate landscape construction, you should consider root pruning well in advance of construction to lessen the impact.

The farther away from the trunk the cut, the less likely you are to cut a large root that will have a profound impact on the entire root system.

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“Unfortunately, on most sites, space is limited, and this rule must be bent,” says Gary R. Johnson, a professor of urban forestry at the University of Maryland. “Just how close an activity can come without seriously threatening the survival of a tree depends on the species, the extent of damage, and the plant’s health.”

Johnson offers the following rule of thumb for minimizing root damage. For each inch of tree trunk diameter at breast height (DBH), he recommends allowing for one-and-a-half feet of critical root zone for sensitive trees, or one foot for trees regarded as “more tolerant” of root disturbance. So, for a tree with a DBH of 10 inches, cutting roots no less than 15 feet away from the trunk would reduce the risk of major damage to the tree.

Arboriculture and forestry professionals use a specially graduated tape to determine tree diameter, but anyone can make this calculation by measuring the circumference of a tree with a household measuring tape and then dividing that number by three (3.14, or pi, if you want to be precise).

Some tree species are more tolerant than others of root disturbance (see “Disturbance Tolerant”). Older trees are generally less tolerant of disturbance than are younger trees, so if you have a choice, consider creating a new bed under a younger tree.

Raising the Grade

For small-scale landscaping renovations, adding soil around the base of a tree to provide a planting area is probably a better option than



Disturbance Tolerant

THE FOLLOWING COMMON landscape trees have shown some tolerance of root disturbance or soil compaction.

- Acer rubrum* (red maple)
- Carya glabra* (pignut hickory)
- Cercis canadensis* (eastern redbud)
- Crataegus phaenopyrum* (Washington hawthorn)
- Fraxinus pennsylvanica* (green ash)
- Gleditsia triacanthos* (honey locust)
- Gymnocladus dioica* (Kentucky coffee-tree)
- Ilex opaca* (American holly)
- Magnolia grandiflora* (Southern magnolia)
- Picea abies* (Norway spruce)
- Picea pungens* (blue spruce)
- Pinus banksiana* (Jack pine)
- Pinus virginiana* (Virginia pine)
- Quercus prinus* (chestnut oak)
- Quercus rubra* (red oak)



Opposite: Filling in between surface roots with a thin layer of soil or mulch is generally fine, but avoid covering the roots completely. Construction damage within the critical root zone doomed these once majestic white oaks, left, in Oregon.

cutting roots. This approach has its own potential problems. Adding too thick a layer of soil can starve the root zone of oxygen. Raising the grade around the tree can also potentially divert water and nutrients away from roots.

It has been my experience, however, that adding some soil around a tree will cause less harm than indiscriminate cutting of roots. Experts recommend adding no more than two to four inches of planting medium to the base of any tree at one time. If you decide to take this route, do not let the soil or mulch come into direct contact with the trunk because it can facilitate fungal and bacterial infections. And, of course, avoid those “mulch volcanoes” that are so popular with landscapers.

If you do add planting medium, use a “light” blend of soil—or, better yet, compost—and organic mulch such as wood chips, shredded bark, and pine needles. As it slowly decomposes, this organic matter will condition the soil, moderate soil temperatures, maintain moisture, and reduce competition from weeds and grass.

Rex Bastian, an arborist with The Care of Trees in Wheeling, Illinois, strongly recommends amending the soil around trees several months in advance of planting.

“Mulching first and installing later provides a couple of advantages,” notes Bastian. “First, the soil and mulch mix will have

Plants for Dry Shade

PLANTS GROWING UNDER TREES must tolerate shade cast by the canopy and dry conditions caused by the tree roots’ great intake of water.

The following perennials and grasses fit the bill.

Asarum canadense (Canadian hardy ginger)

Aster cordifolius (blue wood aster)

Aster divaricatus (white wood aster)

Carex pennsylvanica (Pennsylvania sedge)

Chrysogonum virginianum (green and gold)

Convallaria majus (lily of the valley)

Dennstaedtia punctilobula (hay-scented fern)

Epimedium spp. (barrenwort)

Hakonechloa macra (Hakone grass)

Helleborus foetidus (stinking hellebore)

Liriope spp. (lilyturf)

Ophiopogon spp. (Mondo grass)

Polypodium virginianum (rock fern)

Polystichum acrostichoides (Christmas fern)

Sanguinaria canadensis (bloodroot)

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had some time to break down, providing some organic matter to the soil. Second, the organic layer will also help loosen the soil beneath it, making it easier to open holes to receive the plants. This allows a greater depth over the existing root system with which to work.”

A Balancing Act

Landscaping under or around existing trees involves balancing the health of the tree against the needs of the plants you want to grow under them.

When deciding what to plant under your tree, try to match the moisture needs of the new plants with those of the tree or trees they are going to accent. This is important because, as you try to get your new garden established, you might wind up overwatering an existing tree that does not like wet soil. Trees such as birches, alders, bald cypresses, and some maples will thrive in moist soils, but most others do not.

Thirsty trees tend to quickly absorb water in their root zone, leading to the dreaded gardening challenge known as “dry shade” (see “Plants for Dry Shade”). Soil moisture levels are also affected by the “rain shadow” cast by different trees; dense-canopied trees such as maple, beech, pear, pine, and spruce tend to divert water toward their drip lines.

Dense-canopied trees also cast heavier shade than open-canopied trees, which means you have a narrower choice of plants adapted to grow underneath them. To let more light reach your garden, you have two options. The first is to remove some of the lower branches on the tree, which arborists refer to as “crown raising.” The second is to remove some of the interior branches of the crown, which is known as “crown thinning.” Either method should be done judiciously as over-thinning can cause severe damage to a tree.

Establishing Plantings

REMEMBER, once you’ve planted underneath trees you will now have multiple root systems competing for water and nutrients. Be sure to water your new planting regularly for a couple of months until the plants are well established.

After the plants have settled in, gradually reduce the frequency of waterings, but soak the entire planting area thoroughly each time you water. Research shows that deep watering encourages root systems to grow deeper, making plants more drought tolerant and reducing surface rooting that can interfere with your garden. Letting the soil dry between irrigations allows for natural shrinking and swelling that will help improve soil structure.

If you are installing an irrigation system in and around a new garden bed that encompasses trees, make sure the nozzles do not spray the trunk of the tree for any prolonged period. Better yet, consider using sprinkler heads with low application rates, or perhaps bubblers or a drip system. Watering the lower trunk near the root collar can lead to fungal problems.

Rex Bastian of The Care of Trees also cautions against running irrigation lines across tree roots. “Many system installers will simply cut the roots of a tree when installing irrigation,” he says. “Require the contractor to run the main line outside the drip line, and run the branches toward the trunk of the tree like spokes on a wheel. Install a directional head that waters away from the tree trunk to avoid problems.”

Established trees generally don’t need much supplemental fertilizer, but with new roots to feed, you may want to add a balanced slow-release fertilizer (10-10-10 is fine) or compost tea at the time you install your new planting. Once the new planting is established, you can apply fertilizer a couple of times a growing season or amend the bed annually with compost or other organic matter.

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Plant Selection

In general, shallow-rooted herbaceous perennials, bulbs, and ground covers are best suited to sharing soil space with existing tree roots because they need less growing medium and will not require the digging of large holes around the tree.

Small bulbs such as crocuses, snowdrops (*Galanthus* spp.), *Iris reticulata*, and hardy cyclamen (*Cyclamen* spp.) only need to be planted a couple of inches deep (or covered to that depth with new soil) and can be easily integrated between roots. Rhizomatous or shallow-rooted ground covers like hardy ginger (*Asarum* spp.), Allegheny spurge (*Pachysandra procumbens*), crested iris (*Iris cristata*), foamflowers (*Tiarella* spp.), and some ferns are also ideal for such sites as long as the soil remains somewhat moist.

Because they need to be replaced frequently, annuals are not the best choice under shallow-rooted trees, notes Bonnie Appleton, an extension horticulturist at Virginia Polytechnic and State University in Blacksburg, Virginia. Digging fresh planting holes every year has the potential to cause ongoing root damage to the tree.

Two to four inches of soil is not deep enough to successfully plant shrubs with larger root balls. "There is no good way to incorporate a lot of large plants close under a tree without doing long-term damage to the tree," says Nina Bassuk, a horticulture professor at Cornell University.

If you are set on planting shrubs underneath a tree, your best bet is to plant them in phases over several growing seasons. This provides the tree with some recovery time from root disturbance.

If you are planting a bed of mixed shrubs and perennials, consider planting perennials closest to the tree trunk, then gradually integrating shrubs as you get farther away from the tree's major roots.

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Remember, arboriculture, like gardening, is both an art and a science, so there's no magic-bullet solution or rule of thumb that covers every situation. But you'll have better results with your trees and garden plants if you take tree-root health into account before putting shovel to earth. When in doubt, consult a professional arborist rather than make a costly mistake or risk the loss of a treasured tree.

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David Oettinger is a certified arborist with Paul Cowie & Associates, an arboriculture and urban forestry consulting firm in Montville, New Jersey.

Resources

■ *Arboriculture Care of Trees, Shrubs, and Vines in the Landscape*, by Richard Harris; Englewood Cliffs, New Jersey: Prentice-Hall Inc., 1983.

■ International Society of Arboriculture, Champaign, Illinois, www.isa-arbor.com.

■ *Principles and Practices of Planting Trees and Shrubs*, by Gary W. Watson; Champaign, Illinois: International Society of Arboriculture, 1997.

■ Tree Care Industry Association, Manchester, New Hampshire, www.natlarb.com.

■ *Trees and Development: A Technical Guide to Preservation of Trees During Development*, by James R. Clark and Nelda Matheny; Champaign, Illinois: International Society of Arboriculture, 1998.

■ *Trees in the Urban Landscape*, by Peter Trowbridge and Nina Bassuk; New York City: Wiley, 2004.

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