



Soils and Trees

I just had an interesting discussion with two Consulting Arborists that I hold in high regard. To each I asked if I should be adding soil amendments to the backfill for trees I am planting. The interesting part is that the first said no, the trees should adapt and grow out into the parent soil. The second was very much in favor of amendments, including nutrients, in order to help establish the tree. Is there a general rule on this issue?

The answer to most horticultural questions is, "it depends." In this case, the question whether to amend a planting hole or not depends on the soil textural class and the drainage class of the site. For a heavy clay, poorly drained site, adding amendments will result in increased water infiltration; but, due to the poor drainage, a perched water table may be created in the planting hole and cause root death. Adding amendments into reasonably drained, loamy soil is most likely a waste of time and materials, as the site is adequate for growth whether or not you amend. Adding organic matter to sandy soils does help to hold water and nutrients in the root zone and can be beneficial. In all cases, fertilizing at planting is not recommended.

—Barb Neal, RCA #428

The general rule should be "analyze the existing soil prior to planting." I worry most about the physical properties. Is the surrounding soil compacted? A bit of

scarification in the sides of the spaded hole will not improve the chances of root penetration. I pay most attention to the top 15cm (6"). Is there organic matter (OM) in this layer? 5-10% OM as an amendment helps soils develop structure which improves aeration, water infiltration and drainage. If this is established, most chemical problems, such as soluble salts, may correct themselves due to the increased capacity of the soil to leach the salts away from the absorbing roots. If there is OM, air and moisture, microorganisms such as mycorrhizae naturally thrive without the addition of any inoculant.

—Anita M. Schill, RCA #421

I think it depends on the type of soil, the species of plant going in the ground, and the method of nursery propagation. I have noticed that plants grown in arid soil media tend to dry out very quickly in loamy soil, but require additional drainage in low lying clay soils. Occasionally, job specifications require planting of species where site soil type is not ideal. In situations like this, adding soil amendments can be very helpful.

—Marty Shaw, RCA #470

One general rule is: "Aim roots into amended beds." If roots are not aimed away from the trunk, amending is relatively unimportant. Make the tree a bed, not a hole, by breaking the soil up deeper and wider than the typical hole size. There is no harm in amending if

there are no interfaces, and amounts are reasonable. Whether or what to add depends on the native soil and the site and the plant. Much of the research behind the general "rule" not to amend had very narrow applications.

—Guy P. Meilleur

Both Arborists were not as right as they could be. The short answer is no. I do not use soil amendments. I do not recommend other people use soil amendments. The answer is simple, how I came up with it is a little more involved.

I like to look things up. In this case I went to "Best Management Practice, Tree Planting" (special companion publication to ANSI300 +), James Urban "Up by Roots" and Richard Harris, "Arboriculture." All three said you may use soil amendments. Doesn't really answer the question; however, all three agreed on the planting depth and the size and shape of the hole. The important part of planting depth is that the root collar is exposed. As for the hole, the sides should be flared so the feeder roots have a place to start. Now comes the fun part, the part that allows a person to find out the best answer for himself. Try different things; the definition of an expert is someone who has made every mistake. Get on your knees; stick your hands in the soil. Does it feel like it needs amending? Doing things by feel takes practice. Don't be afraid to try different things. Plant five trees with amendments and five without. See what

happens. I have a lot of time in the tree business. I have a lot of education, yet I still get dirty (some days, very dirty) every day.

I don't use soil amendments; I have close to 100% success rate. Try my way, try a different way, just try. In three years you will be telling people the most right answer.

—Colin Milde

I think the general rule should be that a decision about whether to add soil amendments or what amendments to add should be based on the soil you are planting into. A good native soil may need no amendment. A heavily compacted or depleted soil or fill soils (perhaps with debris) may need complete replacement. Unless the soil is nutrient deficient, I've always found moisture management to be more important than added fertilizer. I think some studies have found that if the backfill soil is too dissimilar from the surrounding soil it may not drain well. It may be more important to simply loosen a large area of soil to encourage root spread than to amend a smaller backfill area.

—Scott Cullen, RCA #348

Over the years, I've encountered soil quality and texture ranging from pure sand to impervious clay. My answer to the question of use of amended backfill would depend on the percolation rate of the topsoil as well as the subsoil at the specific site.

If the native site soil is an excellent clay loam, which has percolation rates of 3/4" per hour, the native soil should be used as backfill.

If the native site soil is a sticky, dense adobe clay, I suggest mixing it (when dry) with 40% volcanic rock (organic

material will decompose within two years leaving you with adobe, again).

In other words, it depends.

—Barrie D. Coate, RCA #237

Here in Virginia, we generously call the pot-grade clay that exists everywhere "soil." While the native trees seem to manage somehow, landscape trees usually struggle. No matter where I've planted trees, from NY to SC, or west to OH, the native soil has had issues with which I have had to deal any time I introduced landscape trees that were grown elsewhere. Both the arborists with which the question asker talked are correct. Trees do have to "get used to" the soil in which we plant them, and a little something to help a landscape tree get started is a good idea. The best answer is somewhere in between no amendments and lots of amendments. Before you get to the best answer, though, other things must be taken into account. My planting specs include extra-wide planting holes, at least 3 times the diameter, and no deeper than that of the root ball of the tree being planted. I don't go deeper and then build up a center column and I don't excavate a trough around an undisturbed center column... these activities are wastes of time. The sides of a planting hole can be vertical or slightly sloped. What matters is the hole diameter. If, because of space constraints, the hole cannot be large, either select a smaller tree or plant something else. If neither is an option, have an approximately 45° angle on the sides of the hole. This will facilitate concentrating water at the base while the tree gets established. Make sure the sides of the hole are loose and not glazed.

Now that the hole is sized correctly, we can talk soil. For heavy clay soils, I mix the native soil (read "lumpy, crappy, clay") 60/40 with a topsoil mixture that

is a nice loam. It really doesn't have to be anything on the level of Miracle Gro™ or something similar; it just has to not be heavy clay. A local nursery I work with frequently makes their own planting mix. It's 85% topsoil and 15% OM. If the intended planting spot has very sandy soil, I would tend to go slightly higher on the ratio of planting mix to native soil, but if you're using the right tree for the general soil conditions, you shouldn't have to. I will frequently include Mycorrhizal fungi and ag-grade 10-10-10 into the last "lift" of planting mix, but not do any more fertilization for at least one growing season.

—Jeffrey P. Lange

Experience with using or not using amendments is usually why an expert would recommend them or not. Research about soil amendments done at Cornell, at Univ. of Florida, at Virginia Tech, and probably other universities shows amendments sometimes help in establishment and sometimes have no noticeable effects. I think the soil conditions (soil type, soil depth, drainage, slope, etc.) can be more of a factor than whether or not to use amendments; so doing soil analysis is a general rule to identify if the conditions are good for growing a particular species of tree, or if amendments to "make up the difference" are warranted.

—John A. Harris, RCA #468

I have recently accepted a consulting assignment that involves the care of young, but established, trees (6-10" dbh), which reside on an expansive, eight-year-old commercial site. The trees are struggling in turf-covered, disturbed and compacted soil. Irrigation is not a problem; however, I believe soil quality and compaction are. Are there any best recommendations for improving the soil environment for these young trees?

I've seen dramatic improvement in tree health in sites with compacted, poor soil by use of radial trenching (refer to "Replacing Soil in the Root Zone of Mature Trees for Better Growth," by Watson, Kelsey, and Woodtle, Journal of Arbor. July 96). I recommend digging one radial trench per 2" of trunk diameter in November. The trenches begin 1-2' from the trunk (avoiding buttress roots) and extend to beyond the dripline at 12" deep. I've recommended mixing the native soil with fir bark or volcanic rock or both, with slow release pelleted fertilizer. These trenches must be water filled frequently for the first year.

—Barrie D. Coate, RCA #237

The short answer is no. There are no best recommendations for improving soil quality. There are, however, lots of ways to do this. If it was me, this is what I would do.

1. Remove the turf out to the drip line, or as far as you can go.
2. Apply Cambistat (paclobutrazol) as per label. This increases root development.
3. Mix organic material into soil. This would be my mulch. I would spread the mulch (double hammered hardwood). I would work it into the soil by hand with a soil knife. This will provide benefits in the future.
4. Soil inject an organic complement. I use 1-2-3 TREE, available from Tech Terra Environmental. This is a combination of organics and mycorrhizae.

I like this combination, it's easy and it works.

I will just mention other options. They are more expensive, and I don't think they work that well, but in special cases they are the best options: air and hydro

vacuum excavation, vertical mulching, or radial trenching.

—Colin Milde

Once a tree is planted into a poor site, we have very few tools in our toolkit to help the growing conditions. Air spading and soil replacement is probably your best bet, although it is expensive. Creating a wider mulch ring by removing turf and mulching with compost may help as well.

—Barb Neal, RCA #428

There are a number of strategies to improve the rooting environment. Which is "best" probably depends on actually identifying the nature of the soils. Soil tests will confirm if there are nutrient deficiencies to be addressed. Tests of soil bulk density (SBD) or penetration resistance will indicate if the soil is compacted enough to inhibit root growth. A widely used technique is to remove the turf, use an air tool to loosen the soil, and then amend it. Research has shown that soil macroporosity can be maintained by amending with compost. Unless the landscape demands turf, the treated area can be mulched. Even mulching without the "aeration" can be very beneficial. All of this, of course, assumes you identify and treat any stem girdling roots (SGRs) and rule out that the trees were planted too deep.

—Scott Cullen, RCA #348

It would be wise to perform a bulk density test, soil test, and foliage nutrient test to see if there are any deficiencies and apply any missing components. Mulching is probably the best thing you can do to alleviate moderate soil compaction. The addition of composted organic material will increase soil biodiversity and density. All those organisms will cultivate the soil, release nutri-

ents and improve soil gasses. If severe soil compaction is a problem, vertical mulching with organic material can be very helpful. I have also had excellent results with trunk-injected nutrients on compacted sites.

—Marty Shaw, RCA #470

Any time you have grass growing under a tree, you're killing the tree. You cannot simultaneously maintain good turf and healthy trees. The maintenance regimen for grass facilitates—it almost necessitates—soil compaction. Depending on the type of tree about which we're talking—odds are there's a couple October Glory Red Maples in there somewhere—you likely have roots close to the surface, and those roots are getting banged up every time you mow. Bottom line: get rid of as much grass as possible under the tree. Once that's done, consider air spading and limiting your mulch depth to 3". There are a number of companies that now do air spading, and the results I've seen have been great. Once the trees are mulched, leave them alone... or rather stop tromping all over the root systems. If you have irrigation, some of the water may actually get to the roots and be taken up by the trees.

—Jeffrey P. Lange

First, find the flare. Then, use a soil probe to see where the roots are, and how the soil is. Next, see where the water moves, or does not move, on the site. Finally, compromise between the tree and turf objectives, and mulch.

Some companies recommend root invigoration 15-25 cm deep, without even looking deeper. Tree roots need to grow much deeper than that, for stability and health. An iron bar or a miner's pick can fracture the soil 30 cm+ deep.

—Guy P. Meilleur

Improving the soil area around these trees could involve breaking up the soil with an air spade, doing vertical mulching, ground injection with low pressure watering and/or fertigation mix, or other methods to loosen the soil and reduce compaction. Doing soil analysis to identify the nutrients and composition of the soil is a first step, to identify what amendments including fertilizer mix would be useful. Think about organics for the soil also, maybe as part of your mix you are putting into the soil, if you do some de-compacting work.

—John A. Harris, RCA #468

I have increasingly become frustrated with attempting to quantitatively assess soil compaction. After purchasing a soil compaction tester (probe with gauge), I find that soil moisture will cause the readings to vary greatly. Is there a simple method (field method) that I might employ to test (rather than guess) for severity of compaction?

There is no simple method to test the severity of soil compaction. However, we are not building bridges; guessing works. There are ways to guess intelligently. If I am in the woods, compaction is not a problem. If I am on a construction site, compaction will kill my plants. The bulk density will be high. If I am at an old house, compaction will be less than at new house. If there is a pool, compaction will be higher. I also get on my hands and knees with a soil knife. I work in North Jersey—compaction is kind of a given.

—Colin Milde

A number of years ago a colleague posed a similar question to a well-known authority on tree soils. His response was: “Forget fancy instruments and tests; dig a hole; start in any darker topsoil and push a pen knife or screwdriver into the side of the hole. The

topsoil will provide little resistance and you’ll probably find roots in it. As you go deeper and the soil color changes, the resistance will increase and you’ll find fewer roots.” The problem with this approach is that you may have to dig a number of holes. The advantage of a soil penetrometer with a resistance gauge is that you can make a large number of tests quickly. In any soil moisture, you might simply compare soil you believe to be uncompacted (it’s obviously loose, full of earthworms, under a thriving tree, etc.) to soil you suspect is compacted. Consider it a relative rather than absolute measure.

—Scott Cullen, RCA #348

Dr. Frank Gouin, professor emeritus of horticulture from the University of Maryland, recommends using a soil augur (1.25” diameter) to test for compaction. In compacted soil (or at a compacted layer), the augur will not bite down into the soil. This method is also dependent on soil moisture, but I have found it more reliable than a penetrometer. Note: the soil augur I bought screws into a handle, which is problematic when you go to unscrew the augur from the soil! I had to epoxy the augur onto a dedicated handle and buy another handle for my soil corer.

—Barb Neal, RCA #428

After attending an “Up by Roots” workshop with James Urban, I purchased a small-bore sampling kit. Basically, a small sampling cylinder with a defined volume is driven into the ground. The kit comes with a robust “T” handle and a very heavy hammer that I can use to drive the cylinder into the surface. The soil is extracted from the cylinder and dried. Bulk density (Db), a quantitative measure of soil compaction can be calculated by dividing the dry weight of the soil sample by the volume of the cylinder. Depending on the soil texture

(% of Sand, Silt and Clay) the severity of the compaction can be assessed. I can also extract samples further down into the initial bore hole to acquire a full view of how the Db changes with depth.

—Anita M. Schill, RCA #421

Many factors affect penetrometer readings, and this test can only give a reading relative to soil moisture. A bulk density test will give you a definitive assessment of the level of soil compaction relative to soil texture. Since bulk density measures the dry weight of soil in relation to its volume, it tells you how much soil compaction you are actually dealing with while eliminating the influence of soil moisture. A good number for sandy soil is 1.6, while a good number for clay soil is 1.1. Readings of 1.8 in sandy soil or 2.5 in clay soil would be sufficient to inhibit root development. Using a penetrometer in conjunction with a soil moisture meter and comparing the results with the bulk density test may give you a sense of how soil moisture affects soil penetration. With experience, you will get a “feel” for how dense the soil is in varying soil conditions. Since penetrometer readings are not definitive, and rocks and other debris may affect penetrometer performance, I recommend a penetrometer in situations that do not call for a great amount of detail regarding soil compaction.

—Marty Shaw, RCA #470

Here in Virginia, we validly assume we have soil compaction. To field test, however, I use a narrow soil auger to pull as deep a core as possible. The depth to which I can push the auger into the soil gives me a rough idea of compaction. I remove the pulled core sample and drop water on at various places along the length of the sample, wait a couple minutes, then slice the sample length-wise and check for movement

of the water through it. Slightly better than a guess; but you cannot go wrong with a meter.

—Jeffrey P. Lange

Dig some up and try to break it apart with your hands.

—Guy P. Meilleur

We rely on a soil auger (Oakfield Apparatus Co.) to test at 0–2", 2–6", 6–12", 12–24"—making notes of moisture content you can feel and see at each depth.

Any change in texture/moisture content is critical information. The ease or difficulty encountered during screwing the auger into the soil is often sufficient to tell you how dry is dry.

—Barrie D. Coate, RCA #237

I am having difficulty maintaining the health of several mature trees located along a roadway at my client's residence. I know that one key problem is accumulated deicing salts. Do I have any options for reducing the concentrations of salts now in the soil? Are there any options to reduce the quantity of future contamination?

Increased irrigation may help leach out the soluble salts as long as you have adequate drainage. Increasing the organic component of the soil will also increase the soil buffering and reduce the affects of soluble salt. The addition of gypsum is also helpful in salt reduction, and it has other benefits in clay soils. You may want to consider recommending alternatives to salts, such as physical removal of ice with the application of kitty litter or coarse sand for better traction. Use of calcium magnesium acetate has less affect on plants and will not damage driveway surfaces, but it will not be effective below 15° F. If plant selection is a consideration, you

can choose salt tolerant species over salt sensitive ones.

—Marty Shaw, RCA #470

Treatment options include incorporating organic material to buffer the salts, and improving drainage to better flush the salts. Prevention options include changing the plowing pattern, using less salt or a less damaging chemical, extending the mulched area, or installing temporary diversion devices such as berms.

—Guy P. Meilleur

There aren't many options for reducing concentrations of salt in the water table once it's there. Since de-icing products generally pull water away from the tree roots, extra watering can help, both to flush the salts and to allow for more opportunity for uptake by tree roots; but your best bet is to use a different product for dealing with the ice in the future. I would recommend Urea or a sand/cinder mix.

—Jeffrey P. Lange

Deicing salts can be leached from the soil in the early spring by irrigating the site. The best solution to reducing salt contamination is to reduce salt use, or create a barrier so the salt spreaders' application of salt cannot reach into the planting beds.

—Barb Neal, RCA #428

Prior to bud break, sample the surface soil and send it to a soil-testing lab for a soluble salts test (EC) as well as a sodium absorption ratio test (SAR). This will give you some hard evidence that soluble salts, particularly sodium, is the problem. If you wait until after bud break, the salts will have leached down into the soil and the lab results may come back as normal salt levels. The de-icing salts

are not only detrimental because of the sodium content, they usually contain chlorides, which leach down into the groundwater or are removed by surface drainage directly into our rivers and streams. Using wood chips helps collect the salts at the surface over the winter. There will be a white crust on the chips when surfaces dry out in the spring. Prior to any watering, remove this layer of mulch and replace is with uncontaminated mulch. I am caring for mature historic trees and the use of de-icing salts is prohibited, even though there is a high volume of pedestrian traffic every day. They have workers shovel and sweep to remove the snow instead. The improvement was very noticeable even after one winter.

—Anita M. Schill, RCA #421

Finding the source of the deicing salts, from the homeowner or from public maintenance of the road, is a first step in working to reduce the road salt. Meeting with those responsible to know why the road salt is being used heavy enough to damage the plants, and seeing if they can reduce it is the next step. If the salt is present, and plants are damaged, one method for reducing the immediate effects is additional watering to leach through the salts in the soil. Any salts within the plants are already doing damage, but this will help reduce more salts getting in the plants.

—John A. Harris, RCA #468

This question does not give much information to work with. So many things can lead to poor plant health. That being said, there is one way to reduce salt content in soil: lots of water and gypsum. This works best over long periods of time, but it does not work too well. Prevention is much better.

To reduce salt contamination from road salt, place a burlap fence between the

street and the plants, 36 inches is usually high enough. Start the bottom of the fence 3 inches below grade. This will help with seepage.

—Colin Milde

I don't have a good current answer on reducing salt concentrations. Reducing future contamination is straightforward if your client owns the roadway. Simply stop using salt. It is not so easy to do that if it's a public roadway. If the salt is making its way to the root systems in runoff from the roadway, you may be able to direct the runoff away with a curb or berm.

—Scott Cullen, RCA #348

I understand the myriad of benefits provided by mycorrhizae. I also understand that this area has seen significant commercial interest in the last few years. Currently, are there any best recommendations, brands or products for use in within the tree industry?

There is no best recommendation for application of mycorrhizae. In Up by Roots, James Urban states "Adequate composted organic amendment and water remain the best additives to reduce transplant shock and improve long term tree growth" (p. 185). However, Tech Terra Environmental offers a product called 1-2-3 TREE. This product combines organics and mycorrhizae, at a reasonable price.

—Colin Milde

The benefits of mycorrhizae are unquestioned. The benefits of adding mycorrhizae where mycorrhizae do not exist are also without question. Is it wise to recommend the application mycorrhizae on every tree? I'm not so sure on that one? I believe there are limited situations where the addition of mycorrhizal propagules will offer benefits to trees.

For example, sites with soil excavation in the top 3–6 inches and where absorptive roots are damaged, and sites with extreme acidity or toxins can all benefit from the addition of mycorrhizal inoculums. Be sure to check the labels and make sure the species of trees and mycorrhizae are compatible (i.e., VAM vs. ectomycorrhizae) and that there are adequate live propagules in the product for effective inoculation. There are a few major suppliers—Plant Health Care and Mycorrhizal Applications, Inc. are two suppliers that I trust.

—Marty Shaw, RCA #470

Fresh mycorrhizae harvested from healthy trees of the same species can be the best product possible. Insert into areas where soil is broken up around the dripline and wherever the soil is poor, and inject by washing it in with a garden hose.

—Guy P. Meilleur

I might be old school, but Dr. Alex Shigo told me that decaying leaf litter contained all the fungi that a tree would need to form a mycorrhizal relationship. The reason I do not recommend the use of a "mike" product is that people then ignore the importance of improving the physical properties of the soil—to reduce soil compaction and to add organic matter (leaf litter, compost...). I also look at improving a soil's chemical properties such as pH, soluble salts, and carbonates. If the physical and chemical properties of the soil are ideal for microbial growth you do not need to add any mycorrhizae products, the naturally occurring organisms will flourish on their own.

—Anita M. Schill, RCA #421

A knowledgeable consulting arborist told me years ago that in preparing her masters thesis, she found that

mycorrhizal fungi added to soil around mature trees did not produce a demonstrable benefit; but mycorrhizal fungi added to cutting flats of manzanitas, remained with the plants as they were transplanted. I have not been able to see demonstrable benefits where we've used them; but I recommend them when the client wants them. Independent research is really needed on the subject.

—Barrie D. Coate, RCA #237

I would look at recent literature for any studies on the effectiveness of these products. I think some recent research may have been done by Prof. Christina Wells at Clemson and by the Bartlett Lab.

—Scott Cullen, RCA #348

Bio-Organics makes a line of products that work well, as does Mycorrhizal Products. There are others. I would recommend using a company that can get you several different forms, so you don't have to look up another source should your needs change.

—Jeffrey P. Lange

The biotic portion of soil is responsible for many functions for healthy plant growth. Since the majority of soil organisms (at least the helpful ones) are aerobic, the more we concern ourselves with providing a soil with plenty of pore space, the better off we will be. Scientists have studied commercial preparations of mycorrhizae, and found very little benefit from the applications—and that, quite often, the organisms are no longer alive. See <http://www.ag.purdue.edu/hla/Documents/Mickelbart/other/2009%20INLN%2069%204%2034.pdf> for a summary of research on commercially available mycorrhizae. 🌱

—Barb Neal, RCA #428