ALTERNATIVES FOR IMPROVING SOILS DURING CONSTRUCTION

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Good maintenance programs are essential if a quality turf is to be provided. But even the most intensive and careful maintenance efforts will not be able to provide that quality turf if the wrong grasses have been established or if difficult soil conditions exist.

The old adage -- "DO IT RIGHT THE FIRST TIME" -- is most appropriate in turf establishment. If the turf manager 1) selects the appropriate species and cultivars which are well adapted to the conditions of soil, environment, management, irrigation, intensity of use and quality of turf desired, and 2) has established those desired grasses on a soil which is reasonably adapted to the expected use conditions and which is proprerly prepared, then the maintenance problems will certainly be fewer than if these conditions are not met. This dicussion will concentrate on the soils and soil modification aspects of turf establishment.

When a problem in turf management develops there can be any of a number of causes. Poor soil conditions are sometimes a major cause or at least a contributing factor in the problem.

Soil properties can be divided into 3 major areas: physical, chemical and biological. Soil problems on turf sites are most often associated with limiting physical properties of the soil, but problems can occur in the other areas as well.

Physical Properties

The basic physical properties of soils are soil texture and soil structure. These two major categories influence several other physical properties which are dependent on pore spaces in the soil. Since plant roots grow in pore spaces it is important to understand their significance.

Soil Texture refers to the relative sizes of the mineral particles making up the soil; that is, the percentages of sand, silt and clay. Considering the percentages of these components, soil can be divided into 12 different soil textural classes with the use of a textural triangle. But for practical reasons we can reduce these to 6 major groups based on their management problems and needs: clays, clay loams, loams, sandy loams, loamy sands and sands.

The finer soil particles, particularly the clays, provide greater water holding capacity and nutrient holding capacity (cation exchange capacity or CEC). By contrast, sands provide large pores which allow for quick drainage, good aeration and easy rooting, but do not hold much water or nutrients. Sands are less susceptible to compaction, although any soil can be compacted with sufficient traffic under the right moisture conditions. Of course, the sands can also become very hard when the turf becomese dry, as with any soil.

Soil Structure is the second major physical property and refers to how the sand, silt, clay and organic matter particles are arranged or put together. If "good" structure exists in a loam or clay loam soil there will be individual grains of each particle held together by organic matter and clay particles. This allows for a combination of large pores for aeration and drainage, as well as small pores for holding water. Where such soils are compacted (poor structure) the large pores are lost with some increase in small pores. Thus the more compacted the soil the fewer large pores, the more dense the soil and the slower the drainage and aeration and the poorer the rooting.

Preferred textures

Since soils higher in silt and clay are more susceptible to compaction from traffic it is wise to use sandier soils for high traffic areas. Thus we have wide use today of "USGA", "PURRWICK" or sand/peat mixes in golf course construction; "PAT" football fields; and sand topdressing of golf greens and athletic fields, all of which stress the use of sand. Some of these topics have been discussed in other talks on this program.

My personal preference for the desired soil texture of topsoil for home lawns and other areas with limited traffic is loams (including silt loams and heavy sandy loams). In low traffic areas, the finer textured soils such as clay loams can be used very nicely as well. But for greens, tees, athletic fields, tennis courts and other high traffic areas, the preference is for loamy sands. Loamy sands hold a little water and small amounts of nutrients, but drain very well and are reasonably resistant to compaction. The limitation on water and nutrient holding capacity can be managed easily by more frequent applications of water and fertilizers at lighter rates.

Of course, on most sites budget precludes being so specific about texture, but why not aim for the "ideal"? If that is not possible, then one has to decide just how far from "ideal" soil conditions one can vary. That becomes a matter of careful evaluation of use expectations and resources (budget, equipment, labor, irrigation, etc.)

Many turf managers like to use 100% sand or a sand-peat mix. This allows for excellent drainage, a necessary property in high traffic areas. But the lack of nutrient and water holding capactiies make them more difficult to manage. Water management is particularly crucial. And the development of localized dry spots due to hydrophobic soil conditions is common on sands. This can usually be solved with an effective wetting agent program in combination with cultivation and careful watering. The point is that sands provide quite a different medium for turf growth than soils which have some silt and clay, so the sand must be managed differently. There have been too many failures on sands because the turf manager tried to use the same management practices as on regular soils. Sooner or later this will lead to trouble.

A further concern on sands is that if the turf is lost at some point, reestablishment of the dead spots within the existing turf is much more difficult than on soil mixes because of 1) the lack of stability of a sand which moves or ruts easily when no sod is present, and 2) the limited water holding capacity which makes it necessary to water several times a day to encourage germination and establishment without seriously interfering with use of the adjacent turf.

The location and purchase of sufficient quantities of a quality topsoil (if, in fact it can be found) and the transportation of that soil to the site are often prohibitive cost-wise. Soil variability is also very common in Michigan so the texture can vary widely from one part of a field (or soil pile) to another. Most people do not understand the importance of having a uniform soil on a high traffic area. I remember a football field which was being rebuilt after a collosal failure in rebuilding just 4 years earlier. The appropriate quantity of an excellent light sandy loam was located and arranged for. At the end of one week, about 3/4 of the field was covered with the good new soil. Over the weekend, the owner of the topsoil decided he needed some fill around a building, so he proceeded to use the good topsoil! The only other topsoil available in the area was a loam soil. Today that football field has one quarter of the area which tends to stay wet and is more difficult to manage. I encourage placing a very high priority on uniform soil conditions for ease in turf management.

Depth of soil

It is very important to consider adequate depth of soil when preparing a site for turf establishment. Most people acknowledge that it is difficult to maintain stress tolerant turfs when there are distinctly different layers of soil within the rootzone or when a shallow rootzone exists. These layers tend to restrict air and water movement and turf rooting. Turfs with restricted roots will not be stress tolerant. At some point in time one can be sure that problems will occur in maintaining the desired turf.

My suggestion is that for general turfs with limited traffic (most home lawns) a uniform soil to a depth of 6 to 8 inches is preferred, with a minimum of 4 inches accepted. If a sufficient quantity of desirable topsoil is not available it is necessary to put down whatever depth of soil is feasible cost-wise and mix that uniformly to the desired depth mentioned.

On intensively used sites, such as golf greens or football fields, a deeper soil is suggested, preferably in the range of 12 to 14 inches. On athletic fields or tees, an intermediate depth, of about 10 inches would be acceptable; but deeper is better. If one is using sands in greens construction, a depth of 10-12 inches can be a adequate if a coarser sand is used, while 12-14 inches is suggested for finer sands. These depths are based on "settled" depths. When loose soil is placed on a site, one can usually assume there will be at least 25% settling. That is, 16 inches of loose soil may settle to 12 inches ultimately. Remember to account for this in calculating the volume of soil needed.

In most cases, it may not be reasonable to expect these depths of soil to be used, but as the layer of uniform topsoil becomes shallower, the potential for maintenance problems increase. It is assumed that these soil mixes will be placed on an underlying soil that is adequately drained, either naturally, or artificially with the use of slope and tile, where needed.

Chemical Properties

The chemical properties of soils include cation exchange capacity (CEC), soil tests for pH and available nutrients, and for potential harmful levels of soluble salts or toxic chemicals. Soils higher in clay and organic matter have a higher CEC which provides some buffering against rapid chemical change. For example, available potassium can be readily leached from a sand while clays will hold the potassium ion strongly, dramatically reducing leaching potential.

Soil pH and available nutrient levels can be determined by soil tests and appropriate treatments applied. Soil chemical properties should not be a problem in turf management if one is careful in soil selection and follows good management practices. Exceptions would be 1) high soluble salts (only a problem in Michigan where salt contamination has occurred), 2) toxic chemicals, resulting from a chemical contamination (both of which are very site specific), or 3) where soil pH is very high. If a lower pH is preferred, one can test soil materials for pH before selection. And there are means of reducing soil pH if that is important, but there is greater potential for problems when lowering pH than in raising pH of an acid soil by liming.

Biological properties

All the organisms which are active in the soil including plants, are part the biological activity of the soil. Soil organic matter serves as the food source for many desirable organisms. A soil low in organic matter will not have as wide range of desirable organims. Of course, some of the organisms present have pathogenic activity, so it is wise to have as wide a range of organisms as possible to provide competition for the pathogens. This does not guarantee freedom from disease by any means. The desirable soil organisms also require aeration, moisture, and nutrients, just as do plants. A soil which is ideal for plant growth will normally have a good range of active organisms as well.

When selecting soil materials, look for topsoil which has a good level of natural organic matter, that is, it has a dark soil color. This will provide a good base for desirable organism activity in the soil. Be careful to avoid the use of mucks, however, which are very black and have poor physical properties for soil mixes.

Amending soils

If the desired soil is not available in sufficient quantity, one can amend the soil to improve its properties. The objectives in amending soils are to achieve the following soil properties: 1) rapid infiltration and drainage; 2) adequate aeration; 3) reasonable CEC; 4) adequate water holding capacity; 5) minimum compaction tendency; 6) resilience, that is, the soil is not "rock hard" (undesirable for ball players of golfers); 7) acceptable soil chemical tests; 8) allows deep rooting; 9) freedom from toxic chemicals; 10) presence of desirable organism (reasonable organic matter content); and 11) feasible costs. Common sense must prevail as it is not possible to have rapid drainage and aeration (mostly sand) and high water and nutrient holding capacities (mostly clays) in the same soil.

In selecting a specific material for use in a soil mix, one should evaluate the following: 1) soil texture and structure compared to the ideal; 2) sufficient quantity of soil for your needs; 3) costs of the materials and transportation; 4) soil tests for pH, available nutrients, soluble salts, and harmful chemicals; 5) presence of weed seeds, quackgrass rhizomes, nematodes, and pathogens; and 6) ease and cost of mixing and handling.

In most soil mixes we would use soils and/or sand as the basic component(s) of the mix. Other mineral materials which might be utilized include: 1) calcined clay -- easy to use but expensive; be sure it has a high degree of hardness and will hold up for many years; 2) vermiculite and perlite -- these are not wise for use where traffic will break down the coarse particle size; and 3) slag -- a by-product from the steel industry which can vary in particle size and chemically. Check out any of these materials carefully before using them.

Thus topsoil and sand are the two most feasible mineral materials which will likely be used in soil mixes. With sands, check for: 1) particle size range, particularly watching for undesired fines or gravel -- usually a narrow particle size range will give the best drainage and aeration; 2) the mineral content -- silica sands are the hardest and will not weather down to smaller sizes; and 3) the presence of free carbonates -- check the pH and watch for the presence of shells, a sure sign of a high pH. In some parts of the country one should check salt levels also.

Check out topsoil sources carefully as well. Evaluate not only the physical properties of texture and structure, but also the chemical and biological properties. The presence of quackgrass rhizomes is objectionable for any turf site except greens and similar areas where the grass is mowed so short that quackgrass will not survive. And "black dirt" is too often just that -- a very black material which usually is finely divided (very small particles) muck and often is loaded with weed seeds. Thus it is generally considered undesirable for use in a soil mix.

Organic amendments can be used to add organic matter which should be helpful in stabilizing soil structure, improving pore space in finer textured soils and improving water and nutrient holding capacity on sands. Materials which can be used include peats, sawdust, shredded bark, manure, spent mushroom soil, sewage sludges and composted materials. These materials can vary widely in degree of decomposition; pH; toxic chemicals; available nutrients; particle size; presence of silt, clay and other fine or coarse materials; ease of handling and mixing; and cost. Evaluate each carefully before using. Many of these may be free or have a minimal cost, but a short cut at the time of construction can be very costly in management later on.

An example, is peat which can vary from a fibrous, light brown material to a highly degraded muck, which contains may fines and weed seeds. Normally, the browner the material and the coarser the fiber, the higher the cost and the better it is for use in a soil mix.

Sawdust and shredded barks may have toxins present or may have a high nitrogen demand if not aged. Manures and sludges vary widely in physical conditions and presence of straw, nutrients and soluble salts. Sewage sludges also are highly variable. Spent mushroom soil can be very high in salts. So do your homework before selection of an organic amendment for your soil mix.

It is usually wise to get professional help in selecting a soil or when deciding how much of a given amendment to add to the soil. Commonly, people talk of a 1-1-1 or 2-1-1 mix, speaking of parts sand to parts soil to parts peat by volume. This is not valid. The texture of the original topsoil is of greatest importance. For example, assume you have a clay loam which has 33% clay, 33% silt, and 34% sand. Compare this to a sandy loam which has 10% clay, 30% silt, and 60% sand. Mixing 2 parts of sand with 1 part of the sandy loam by volume will give a soil which has 3% clay, 10% silt and 87% sand (now a loamy sand). It will require about 4 parts of sand to 1 part of the clay loam soil to achieve a loamy sand (6.5% clay, 6.5% silt and 87% sand) in the final mix. The type of clay can also have a dramatic influence on the final properties of the mix. In Michigan there is normally a range of clays present so no one tends to predominate and influence the soil mix in unusual ways.

Once a desired mixing ratio is established, it is essential to pay very careful attention to being sure the appropriate amounts of each is used and are mixed well. Poor mixing of soil materials, a common occurrence, can lead to almost as many problems as a poor mix.

By involving professional assistance for major construction or reconstruction projects, one can reduce the potential for maintenance problems later. A word of caution, however, not all landscape architects have that combination of training and experience which allows them to understand soils sufficiently well to be assured of a good soil mix. Check on the successes (and failures) of the people with whom you may work.

Secondly, stretch your budget as far as you can in order to DO IT RIGHT THE FIRST TIME. To paraphrase an old saying -- "If I don't have the time or money to get it right the first time, how in the world will I have the time or money to redo it later?"