Toxin-Free Lawn & Landscape Manual 2015
The Perfect Earth Project’s Toxin-Free Lawn and Landscape Seminar is supported by the Long Island Sound Futures Fund and the National Fish and Wildlife Foundation. By participating in this event, you are contributing to the health of the Long Island Sound estuary through reduction in nutrients and toxins into the watershed.

Learn More at: http://longislandsoundstudy.net
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PART ONE: Culture and Pests

KINDS OF COOL SEASON TURF

Kentucky Bluegrass: Wear tolerant, recuperates well, excellent traction, cold tolerant, slow to establish so wait minimum 180 days for intensive use, most are sun only. Can have major disease issues. With 80% Kentucky bluegrass 20% rye mix, intensive use is okay in 90 days.

Perennial Rye: Good wear tolerance, tough root system, compaction tolerant, can be enhanced with endophytes for disease and surface insect resistance, best choice for overseeding worn or diseased areas due to rapid germination and fill in, sun only.

Fine Fescue: Cannot take foot traffic, best choice for dry shade, tolerates acid soil, does not tolerate high fertilizer and wants only half the normal rate of fertilization, extremely drought tolerant, (excess irrigation thins fine fescue), can be enhanced with endophytes for disease and surface insect resistance, tight growth habit helps to exclude weeds, best choice for infrequent mowing, may take on bronze color in full sun.

Types of Fine Fescue:
- Creeping Red Fescue: Dense turf, with weak rhizomes
- Strong Creeping Red Fescue: Less dense turf, better rhizomes, spreads well
- Chewings Fescue: No rhizomes, very dense, not as temperature extreme tolerant but considered most attractive of the fine fescues
- Hard Fescue: No rhizomes, better disease and drought resistance than creeping fescue, slow growing and well adapted to shade and poor soils
- Sheep Fescue: Used for soil stabilization, makes a clumpy turf; very drought tolerant and does well on gravelly or sandy soil; does not need to be fertilized

Tall Fescue: Best grass for Long Island, deep fibrous root system, excellent drought tolerance once established. Include 5-10% Kentucky bluegrass in tall fescue mix for fill in of divots. Disease tolerant unless overwatered, moderate shade tolerance, can be endophyte enhanced for disease and surface insect resistance, grub resistant. Tall fescue grows rapidly, so must be mowed frequently. Frequent mowing also helps it remain drier with less humidity in the canopy, stimulates dormant buds, and helps turf remain denser. Mowing once a week or more is best.

Poa trivialis: Very shade tolerant grass for chronically wet sites only. Has a very shallow root system so will only work in moist areas. The least heat tolerant and wear resistant of cool season grasses.

HOW TURF GROWS
- Rhizomatous (Kentucky bluegrass): Spreads laterally BELOW ground, fills in well.
- Stolons (Poa Trivialis): Spreads laterally ABOVE ground, bentgrass.
- Bunch (perennial rye, tall fescue, fine fescue): Does NOT spread laterally, therefore must have tight overseeding, reseed damage immediately

TIP: Always have about 10% bluegrass in the mix, in full sun, to help fill in holes that develop in the lawn. Rye and most Kentucky bluegrass are shade intolerant.
SEED MIXES AND RATES
In lbs/1000 sq ft, the Seeding Rate Rules are roughly:
KENTUCKY BLUEGRASS: 2lbs/1000
POA TRIVIALIS: 1-2lbs/1000
FINE FESCUES: 5lbs/1000
  - Chewings: 3.5-5
  - Hard: 3-4.5
  - Meadow: 7-10
  - Red: 3.5-5
  - Sheep: 3-4.5
TALL FESCUE: 8-12lbs/1000
PERENNIAL RYE: 7-10lbs/1000
KENTUCKY BLUEGRASS/PERENNIAL RYEGRASS MIX in percent by weight: 80-20 to 90-10: 2-4lbs/1000
KENTUCKY BLUEGRASS/TALL FESCUE mix: 10-90 to 20-80: 7-10lbs/1000
KENTUCKY BLUEGRASS/FINE FESCUE mix: 30-70 to 50-50: 2-5lbs/1000
KENTUCKY BLUEGRASS/PERENNIAL RYEGRASS/FINE FESCUE mix: 45-5-50 to 60-10-30: 3-5lbs/1000

Typical Mixes or Blends for Specific Conditions
Sunny, medium to high maintenance
65% KENTUCKY BLUEGRASS, several different varieties
15% PERENNIAL RYEGRASS
20% FINE FESCUES
Seed at 3-4 lbs/10000

Sunny, low maintenance
65% FINE FESCUE blend
15% PERENNIAL RYEGRASS
20% KENTUCKY BLUEGRASS
Seed at 4-5lbs/10000

OR

100% TALL FESCUE blend, Seed at 7-10 lbs/1000

Shady, dry areas
100% FINE FESCUE blend
Or shade tolerant TALL FESCUE

Shady, wet areas
100% POA TRIVIALIS

Blending Your Own Seed Mix
To produce the number of pounds of a particular grass you want in a mix, use this formula: % of seed suggested, decimal placed in front X number of pounds total seed mix desired. For example, if you want to make 25lbs of seed mix total, 10% Kentucky bluegrass, then: 0.10 bluegrass X 25lbs = 2.5lbs of bluegrass in your 25lb mix.
Recommended Varieties of Cool Season Turfgrass
Check the National Turfgrass Evaluation Program, www.ntep.org, to find well-performing varieties for our climate. Use data generated at Rutgers University in New Jersey; their climate is most similar to Long Island.

New varieties that have done well:
- Tall fescue: Bonanza, Phoenix, Taurus, Rebell II, Finelawn
- Kentucky Bluegrass: Bristol, A-34, Ram I, Chateau, Kenblue, Midnight, Georgetown
- Fine Fescue: Aurora, Scaldis, Spartan, Reliant, Valda Waldina, Spartan
- Perennial Rye: Allaire, Pennant, Patriot II; Palmer

TIP: Fertilization at establishment can influence types of grass in future seasons. If you have a mix of Kentucky bluegrass and rye, and turf receives heavy N (Nitrogen) shortly after rye germinates, rye will take over the stand. Kentucky bluegrass is slower and can’t compete. This is also related to percent of rye originally in the seed mix. A mix of Kentucky bluegrass and fescues given high N causes Kentucky bluegrass to dominate. Give the mix low N, fescues dominate.

TIP: Fertilizer composition used the year after establishment can affect turf growth. The year after seeding when using a regular fertilizer, the proportion of N to P (Phosphorous) to K (Potassium) affects the amount of grass growth. We will see more no P fertilizer combinations due to new laws. You may be able to manipulate ratios for better results:
- No P, low N formulation: Make sure K is also very low or you will have less turf growth.
- No P with moderate to high N levels: K level is not as important.
- No P with very high N: K will improve growth.

ENDOPHYTIC GRASSES
Endophytes are good guy fungi that grow within certain turfgrass plants like fescues and ryes, but not in Kentucky bluegrass. You can buy endophyte-enhanced seed, but not all endophyte-enhanced turf seeds are alike. Look for the term “enhanced” and a percentage associated with it; the higher the better. It is not enough to say endophyte “infected,” or “enhanced,” without the percentage. Endophytic fungi produce alkaloid compounds that confer resistance to turf against surface feeding insects like chinch bugs, some resistance to drought, and some resistance to diseases like red thread. These alkaloids are not translocated to the roots, so there is no resistance conferred for grubs. Overseeding with endophytes for a couple of seasons can get rid of chinch bug infestations.

TURF SUNLIGHT REQUIREMENTS
EVALUATING LIGHT: Turf needs 4 hours of sun daily to survive, 6 hours to thrive. Given this constant, grade your site for turf growth potential in the following way:
Grade A = 8 or more hours of light
Grade B = 6-8 hours
Grade C = 4-6 hours
Grade D = 2-4 hours
Grade F = less than 2
Heavy shade = less than 25% daily sun.
Shade above 85% just can’t grow turf.
MOWING AND GRASS CLIPPINGS; SPECIAL EVENTS
Turf should be kept at a height of 3” all season.
- When grass approaches a height of 4” mow it back to 3”.
- If you are currently mowing at less than 3” every 1/8” of grass blade added increases leaf surface area by 30%.

Short grass (under 2.5”) equals short roots. There is not enough food to go around to roots and blades. Short grass means hotter, drier soil, with few roots to pull water through the plant for cooling. This means greater risk of crown damage, which means thinner grass, which means weeds.

If you need to mow low for an event, try several weeks of 0.25” height reductions.
- Once you reach desired height; mow three times a week to encourage new buds from the crown to maintain density.
- As soon as the event is over, raise mowing height immediately.
- Avoid heavy fertilizer applications to make a turf stand green for a party, especially if turf has been mowed low. Instead, spray liquid iron to darken turf and make it more uniformly green for visual purposes. This will mow off after about a week. Be careful of concrete; it can be stained by these products. (Cosmetic use of iron is much healthier for turf and environment than a heavy hand with nitrogen.)

FERTILIZERS
Use 2lbs of actual nitrogen per 1000sqft/year to grow decent rye, Kentucky bluegrass, or tall fescue. Fine fescue will cope with 1lb of actual nitrogen per 1000sqft/year.

To determine how much of any fertilizer product will give 1lb of actual nitrogen per 1000sqft:
Divide the number 100 by the N number from the N-P-K ratio on the fertilizer package. This tells you the amount of fertilizer product for 1lb actual nitrogen per 1000sqft of turf.

To determine how quickly your product choice releases its nitrogen:
Divide the number corresponding to the slow release nitrogen portion as listed on your package by the N number from the NPK ratio.
- An answer below 0.15 indicates a fast release product.
- An answer above 0.29 indicates a slow release product.
- The recommended level for slow release products for turf is between 0.5-0.7 (50-70%) for best results during the turf growth cycle.

Fertilizer Application Times and Schedules
If your fertilizer has more than 30% slow release nitrogen, the following timing options apply.

To reach your total goal of actual nitrogen for the year:
- Three applications: Third week of April, last week of August, second week of October.
- Two applications: Third week of April, second week of September.
- One application: Second week of September.
- “Spoon feed:” Use 1/4-1/8lb per week April 15-October 30.
NATURAL FERTILIZERS Byproducts or waste products of plants or animals.

- Bat guano: Nitrogen contents fast or slow release, depending on source. pH slightly alkaline; no value as soil amendment, useful as quick-acting early growth stimulant.
- Blood meal: No value as soil amendment. pH slightly acid, excess will burn foliage.
- Raw bone meal: Has a variable NPK analysis and is a slow release source of nutrients.
- Steamed bone meal: Slow-moderate release of nutrients, no value as soil amendment.
- Chicken manure: Moderate-fast release; it can burn your plants. pH tends to be alkaline. Water it in; good for moisture retention in sandy soils.
- Cotton seed meal: Acidic pH, provides good moisture retention as soil amendment. Slow to decompose.
- Cow manure: Dairy cow preferable to beef cow; less weed seeds and lower salts. pH generally alkaline, medium release rate. Improves soil texture and organic matter.
- Fish meal: Has a lot of slow release nitrogen. pH is acidic, but does not improve soil.
- Oyster Shells: No fertilizer value but strongly alkaline and can improve drainage. Must be washed well or can lead to excess salt.

HOW MUCH IRRIGATION FOR YOUR TURF
Where does the convention, 1-1½” of water per week, on a deep and infrequent basis, originate? It comes from the amount of water needed to penetrate the entire soil profile depth surrounding your turf root system.

If you figure the very best turf root system should go down about a foot, then we apply the constant: 1” of water applied in a single application penetrates to a depth of about a foot as well. 1½” of water insures a consistently moist, 1ft profile. By contrast, light and frequent irrigation can result in a dry pocket of soil between surface and deeper water in the soil profile.

Questions:
On a very rough basis, how long does it take your sprinkler system to water a 6-9” root system, the average on less than perfect turf growth sites? How does your soil texture figure into this?

To wet soil 6-9” in depth:

<table>
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<th>If in 15 min. your system applied:</th>
<th>Sandy Soil</th>
<th>Intermediate</th>
<th>Clay Soil</th>
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<tr>
<td>1/8”</td>
<td>30 minutes</td>
<td>60 minutes</td>
<td>120 minutes</td>
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<tr>
<td>1/4”</td>
<td>15 minutes</td>
<td>30 minutes</td>
<td>60 minutes</td>
</tr>
<tr>
<td>3/8”</td>
<td>10 minutes</td>
<td>20 minutes</td>
<td>40 minutes</td>
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If we wet soil to a 9” depth, using the chart this means we have applied ¾” (0.75). For most soil types, if we do this twice a week, separated by 3-4 days, this should top off the soil column around the roots and keep roots consistently, but not overly, hydrated. Install a rain sensor and use a rain gauge to compensate for natural precipitation. The best irrigation is not “set it and forget it,” but manual operation based on natural precipitation and weather conditions.
TIME OF DAY TO IRRIGATE YOUR TURF
Turf is naturally wet from dew during the period between midnight and 8AM. Irrigation should correspond to this time period. Watering during the day does no harm, but accelerated evaporation caused by wind and sunshine means turf will not get as much water as you think you are delivering.

Watering between 4PM and midnight CAN harm your turf. Prolonged leaf wetness overnight can enhance or promote disease, much in the way constantly wet feet can lead to foot fungus. This is particularly true for dollar spot disease.

DOES THE TURF HAVE ENOUGH WATER?
Footprint Test: Stomp on the turf so you can see your footprints. Leave for 30 minutes and come back. Are the prints are still clearly visible? If so, the turf needs more water.

Screwdriver Test: After watering, push a screwdriver into soil to a depth of 6-9”. If the barrel feels powdery when withdrawn, more water is needed. If it is smeary, less water is needed.

LOCALIZED DRY SPOTS AND WATER REPELLENT SOILS
Water Droplet Test: To determine if soil is water repellent, remove intact cores with a soil probe. Allow to air-dry several days. Water repellency is determined by placing small drops at increments of 0.5” on the surface of the core starting at the soil surface.

WETTING AGENTS
These are used for improving wetting of LDS, improving drainage in layered soil profiles, improving drainage in heavy traffic areas, increasing product efficacy, and increasing water efficiency. This leads to reduced irrigation costs and speeds root growth under dry conditions. ALWAYS use non-ionic wetting agents: esters, ethers, alcohols.

THATCH
Thatch can result in localized dry spots, and is unlikely to be found in high traffic areas. Measure a thatch layer by slicing through the soil and looking at the layer of material between the crown of the grass and where white, active roots are located. A normal thatch layer may have one part that is crumbly and decomposing; ignore this. Measure the part that resembles a woven, intact carpet of dead brown roots. If less than ½” of this material is present, leave the turf alone. It acts as a “carpet pad” for the turf crowns, the heartbeat of the plants.

Thatch is composed of dead and dying roots that collect faster than they can be broken down by soil microbes. Usually this is due to acid pH, in which case liming may help. Core aeration to increase oxygen to soil microbes and to bring microbes into contact with the thatch layer is better than using a dethatching machine.

Dethatching machines bring crabgrass and annual bluegrass seed to the surface and in spring provide gaps for weeds. If you dethatch in fall, you provide gaps where moss can take hold. Moss lifecycles are different than turf; moss will thrive and invade in winter when turf is weakened by dormancy or stresses like dethatching.
IS THE TURF REALLY DEAD AND WILL IT RECOVER

1. In area you suspect is dead (brown leaf blades) pull some of the blades out.
2. Where blades were removed, look closely for signs of new growth from crown located at ground level.
3. If crown is pale green or white, plump, and juicy it is still alive. New turf will emerge shortly.
4. If crown is brown and rotted, it is dead. It is time to overseed. For rye and tall and fine fescues, reseed dead spots larger than 3” in diameter. For Kentucky bluegrass, reseed dead spots larger than 6” in diameter.

If you are still not sure if turf is alive: Bring a piece inside, place it in a sealable plastic bag, and treat it like a houseplant. Within a week, you should know.

COMMON REASONS TURF THINS & FAILS WITHIN FIRST YEAR OF ESTABLISHMENT:

- Poor quality soil.
- Lack of planning for water draining from roof/sidewalks, foot traffic from pets/people, seed selection based on amount of sun, compost to amend entire turf area properly, etc.
- Improper soil preparation: Till at least 6” deep, preferably 8-10” or even 12”. Raking lawn to a final grade is critical, especially for sodded lawns, so uneven pockets do not sink and leave roots dangling in empty air under the turf canopy where they will die. Remove old sod with a sod cutter rather than coarsely chopping up the old lawn and turning it into the soil.
  REMEMBER: The bucket of a skid-steer loader is not the proper tool for creating the seedbed before seeding or sodding!
- Wrong date of seeding: August and September are the best seeding months. Other seeding dates are doable, but more attention and labor will be needed for success.
- Poor choice of seed: No rye in shade, tall fescue with about 10% Kentucky bluegrass in sun, fine fescue best for dry shade, Poa trivialis for always wet, compacted shade.
- No irrigation after seeding: Usually you will need to irrigate 2-4 times/day to keep the seedbed moist. If new seedlings dry out even once they will die. They do not have roots to fetch moisture deeper in the soil profile.
- Failure to re-fertilize when turf reaches about 2” in height 4-6 weeks after sprouting. This follow up fertilization is REQUIRED for maximum establishment. Seeding turf is likely to run out of food and become very susceptible to damping off unless application of 0.5-1lb of actual nitrogen is made, in accordance with local/state fertilizer laws.
- Bad mowing practices: Mow as soon as the first few plants reach 3” and weekly after that. Most wait too long to mow.
- Crabgrass and bentgrass: Crabgrass will outcompete newly seeded areas, especially those that are hot and dry. Make sure you have chosen the correct grass for the site and there are no gaps in the turf into which crabgrass can grow. Bentgrass will outcompete other grasses in shade, in wet areas, and at the bottom of slopes. Bentgrass is also encouraged by close mowing, high fertilizer, and frequent irrigation.
- Failure to core aerate a sodded lawn can result in sod failure within 6-7 months. Core aeration about 4 weeks after sod is laid is recommended to permit roots to grow through aeration holes into soil, under sod, and into layer of soil sod was brought in. It also opens up channels for air and water exchange and prevents disastrous formation of a perched water table.
- Failure to mulch after seed application to help keep moisture and humidity around germinating grass, promote seed to soil contact, and help keep seed in place during irrigation or rain events. Use about 2 bales/1000sqft of straw mulch. You can also lightly dust seed with soil to keep it in contact with the soil it is planted in.
What is an Unexpected Reason for New Turf to Thin & Fail Within a Year?
Failing to COVER the site once turf renovation is initiated. Heavy rain can cause water movement off adjacent areas onto the turf site. This typically carries and deposits silt and clay, forming a seal on the soil surface difficult for turf seed or sod to root through. A lens of water is also created on the surface that can act as a mini perched water table, leading to algae, moss, and disease, and encouraging run off of fertilizers and washing away of seed. If contamination by particles from off site happens, dig up the surface to reestablish soil air and water exchange, and remove the “crust” from the top.

ISSUES WITH TURF IN WET CONDITIONS
- There is no oxygen in soil for roots; it has been replaced in pore space by water.
- Turf slips against wet soil underneath when pressure is applied.
- Crown tissues are crushed and roots dislodged.
- Wet soils that heat up cause the plant to use more oxygen when there is already very little in the soil.
- If amount of water in roots is lower than amount of water in soil, guttation takes place. Guttation fluid is pushed out of turf tips when soil is too wet, a result of root pressure pushing water up from the root. (When you see drops of liquid at the tips or along the edges of leaves, you are witnessing guttation.) This typically occurs at night when stomata are closed and transpiration is over for the day. While dew covers the entire surface area of the leaf, guttation occurs only at the tip or along the edges. Guttation fluid is high in sugars and minerals used by turf fungi like dollar spot.
- Turf roots are short because of root rot, dysfunctional in taking up water and nutrients, and in cooling the plant off.

Caring for Turf in Wet Sites
- To minimize tracks, set blades to highest mowing height to reduce clipping clumping.
- Make sure blade is sharp; turf in habitually wet conditions is weak and tears off its root system easily when tugged at by dull blades.
- Clear residual clippings from previous sites from under mower deck for a cleaner cut.
- Do a second cut shortly after first in a different pattern to alter track path and minimize tracks in lawn.
- 72” decks seem to handle wet grass better.
- Soil under wet turf is often compacted. It may be causing surface wetness if there is a perched water table. Wetting agents may help water penetrate and move off surface.

Seeding or Reseeding a Muddy Lawn
- Spread straw BEFORE you seed, 1-2 bales/1000sqft. You should see ½ straw, ½ dirt. This will provide a little substrate to walk on, or roll lightweight seed spreader across.
- Seed from a diagonal, so you will not have to walk over any area twice.
- A hand crank seeder may work best in really wet conditions.
- If conditions are super wet and the area is small, seed, then cover with cheesecloth. (You will not have to remove it and it will help to soak up water.)
- You may not need to water for part of the establishment process. You may need to increase seed by 20% to adjust for rot.
- KEEP TRAFFIC OFF: Use walk behind mowers.
Fertilizing a Wet Lawn
Spoon feed. With water saturation a constant issue, roots are likely to be SHORT. No heavy fertilization. Depending on how wet conditions are, possibly no watering during application, or you’ll get top growth roots can’t support, and fertilizer pushed past where roots can get to it. Excess fertilizer + water = disease; especially brown patch (Rhizoctonia). Try a fertility schedule that spoon feeds 1/8lb of actual nitrogen/1000sqft, weekly from mid-April to end of October.

TIP: Fine fescues do not tolerate consistently wet soils.

CARING FOR TURF IN SHADE
It is always better to use an alternative in shade, but if you must have grass, try Poa trivialis. (Rough stalk bluegrass.)

Shade performance of other cool season grasses:
Fine fescue > bentgrass (undesirable) > rough stalk bluegrass > tall fescue
Kentucky bluegrass (shade tolerant) > Kentucky bluegrass (shade intolerant) > rye

Symptoms of Too Much Shade
• Shortened roots
• Reduced wear tolerance
• Reduced shoot density (thinning)
• Decreased vigor
• Elongated, skinny stems
• Increased disease

To Improve Grass Growth in Shade
• Prune interior tree branches to strive for dappled light
• Blow off leaves/debris rather than raking. Turf has shallow roots/thin leaves in shade.
• Use a full inch higher mowing height. (4”)
• Use open, rather than solid, fencing so light can penetrate. (Especially in winter.)
• DO NOT USE RYE IN SHADE; it will always die out yet is so aggressive it will crowd out other more tolerant grasses.
• Morning light is better than afternoon sun.
• Keep the mowing height of this grass at 2.5”, or it tends to flop over and mow poorly.

Growing Grass under Trees:
Best: Birches, gingkoes, and locusts
Worst (heavy shade and/or shallow root systems): Maples, oaks, magnolias, elms, poplars, sweet gums, and willows

Fertilizing in Shade
For most turf stands, it is recommended to fertilize at half the normal rate unless you have heavy traffic, which should be minimized in shade due to shallow root systems and low recuperative ability. Make sure turf has sufficient water as there is competition from tree roots, and canopies can shed water like an umbrella; resulting in a dry zone inside the drip line. Grass will probably need to be renovated every five years or so.
HEAT STRESSED TURF
Cool season grasses hate summer. This means all of our lawns hate summer!

In nature, cool season grasses naturally go dormant during the greatest periods of summer stress, but we artificially keep our lawns going with irrigation. The grass that best tolerates summer conditions on Long Island is tall fescue; the least tolerant grass is Kentucky bluegrass.

What you can expect when certain temperatures are reached:

- **90°** Shoot growth ceases
- **77°** Root growth ceases
- **70°** Max temp. for useful root growth. Ideal temp. to plant grasses other than tall fescue, which prefers it warmer.
- **60-75°** Optimum for shoot growth
- **50-65°** Optimum for root growth

For established turf:
If temps are 90° or higher, or if there is high wind for more than half the day, set sprinkler system to go off multiple times between 11AM and 2PM, in addition to regularly scheduled watering.

- This provides cooling of the grass crown as water evaporates, protecting against "heatstroke" in the crown (the heartbeat) of the turf.
- A heat-damaged crown cannot draw water through the roots and up through the leaves of the turf for evaporative cooling, causing further heat damage and decline.
- Tall fescue has a larger root volume and is superior in drawing water to keep the plant cool.

What Makes Heat Stress Worse?
If turf was on a regimen of light, frequent irrigation before heat stress hit, there will be few functional roots remaining alive in the shallow moist zone created. Once heat stress hits, these roots must work twice as hard to take up enough water to supply the plant for growth, activity, and cooling.

If the roots cannot keep up, heat damage will occur and the plant may die. This creates thin turf, which means no shading of the soil, and even hotter conditions.

What Helps Grass Recover from an episode of Heat Stress?
- Try kelp based amendments.
- Keep mowing height at 3”.
- Overseed with tall fescue enhanced with endophytes.
- Your turf now has a limited root system; it is essential to keep damaged areas cool so crowns can be kept viable by the limited ability of roots, or artificially by syringing.
- Try wetting agents to help spread water around.
- To help trap and hold moisture, treat heat-damaged turf as you would new seedlings or grub-damaged turf and mulch with straw: 1 bale/1000sqft. Or apply 1/8” compost top dressing, and/or an artificial “pontoon” to keep water ponded in damaged area.
TURF IN MEDIANS
- Tall fescue: Best choice, stays greener longer under dry conditions.
- Fine fescue: Poor choice, conditions are too arid.
- Rye: Poor choice due to heavy concentration of road deicing salts.

Roots will be shorter because of soil compaction, so adjust irrigation accordingly. Spoon feed fertilizer, so it will not be lost by runoff or through leaching past short roots. If frustrated by seeding failures in medians, hydromulching is very helpful. Covering seed with cheesecloth is helpful to keep seed from moving offsite. (The cheese cloth will rot away.) You can also use polyester spun fabric, but this must be removed.

For establishing grass seed in early spring, dusting seed with compost or soil may help it to stay in place. Try seeding with 20% more to compensate for seed that falls or is washed over the side.

DOGS AND TURF
Dog urine damage is a bright green ring with a brown spot in the center, while turf disease is usually just a brown spot, or green in the center with a brown ring. Dog urine damage is essentially a salt burn, so treat it as you would a fertilizer burn.

The remedy is watering to dilute urine before 8 hours have passed. If you delay watering for 12 hours or more, burns will progressively worsen. Kentucky bluegrass is most susceptible to dog damage, because it is most sensitive to salt. Tall fescue is least susceptible because it has the highest salt tolerance.

RUTS IN TURF
The first step for most is to tamp down soil surrounding ruts like a bubble in carpet. DO NOT TAM. Instead, stand perpendicular to the rut and loosen soil with a spading fork pushed into it at a 45° angle. Slowly, push depressed soil in rut UPWARD to 1-2” ABOVE the surrounding area. As it settles, it will be level with surrounding turf, with no compaction from tamping.

For deep ruts of more than 4”
- Use an edger or spade to make a parallel cut in the bottom of the rut.
- Use a sod lifting tool or spade to lift each side of the flap and fold it back.
- Loosen the soil in the rut, leaving it 1-2” higher than undisturbed soil.
- Add more soil from an area at the same site if necessary.
- Replace flaps, roll lightly, water well.

It takes about half an hour to go 150ft this way, but it saves the time and uncertainty of procuring topsoil from an outside site and reseeding. The regrowth will be a better match for the existing stand, whereas reseeding often leaves a very visible rut-shaped patch.

TURF TRAFFIC GUIDELINES
When turf is used by 50 or more people each day, there will be damage. After 10 uses per week, allow turf to rest and recover. Minimize use during periods of rain or irrigation. Do not allow play on the thawed surface of frozen turf. The turf will be ruined; the crown crushed and abraded. Grass needs to recover from winter dormancy before use in late winter/early spring.
Is there a better way to oversee turf use and planned activities?
Yes! A single contact person should be responsible for scheduling. There should be a grounds committee to establish a rotation plan, the importance and uses of each turf area, and differences in priority of use by daily users (like students or campers) vs. visitors. This committee should estimate extent of use in each area before it must be rested. Be sure to include soil type and irrigation availability in your committee’s plans. Members should visit each turf site at least twice a year.

SEEDING AND OVERSEEDING
All seed should be evaluated for how much of the product is actually alive. It takes just a moment and will save you money and weed pressure. All you need is the seed label. If the seed does not have a seed label, run the other way!

Calculating Pure Live Seed

- Multiply % purity by % germination for each component of seed mix.
- Add sums together.
- Multiply new number by pounds of seed recommended for over seeding 1000sqft.
- Subtract this number from number of pounds recommended for the overseeding rate.
- Add this amount to the recommended overseeding rate per 1000sqft to compensate for seed that will never germinate.

For example: Recommended overseeding rate is 5lbs/1000sqft.

Look at the SEED LABEL and you find a seed mix is composed of:

<table>
<thead>
<tr>
<th>Percent Purity</th>
<th>Percent germination</th>
<th>% Purity X %Germination</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red fescue</td>
<td>11%</td>
<td>76%</td>
</tr>
<tr>
<td>Kentucky bluegrass var 1</td>
<td>35%</td>
<td>89%</td>
</tr>
<tr>
<td>Kentucky bluegrass var 2</td>
<td>38%</td>
<td>87%</td>
</tr>
<tr>
<td>Perennial ryegrass</td>
<td>16%</td>
<td>90%</td>
</tr>
</tbody>
</table>

0.86 X 5lbs overseeding rate = 4.3lbs of seed that will germinate, out of 5lbs total.
To get 5lbs of seed that will germinate: 5-4.3=0.7
ACTUAL OVERSEEDING RATE IS: 5+0.7=5.7lbs.

HYDROSEEDING
A popular, improved method of quick coverage. Try using a fan type nozzle (50° angle tip is best) for optimal soil surface coverage. Apply flexible growth media to soil surface from opposing directions to reduce shadow effects and ensure minimum 95% soil surface coverage.

Seeding Around New Construction
Wait until grading/plowing has subsided for at least 48 hours, or soil will settle and bury seed too deeply to germinate effectively.

Seeding Other Times of the Year?
Dormant seeding by honeycomb seeding is better done mid-February through late March. Divide seed into 3-4 lots and sow on 3-4 different days, early in morning when still-frozen soil is expected to thaw midday. Cracking and moisture embeds the seed in the soil. Increase seed by 50% for dormant seedings to compensate for bird predation and rot.
Rye seeded by October 1 provides about 60% cover by December 1. Rye needs a soil temp of at least 45°, and like tall fescue, needs a soil temp of 55°+ for best results. Dormant seeding of Kentucky bluegrass on Dec. 1 outperformed spring seedings on April 1 and May 1, and performed almost as well as a September seeding in one study. Kentucky bluegrass, with its slow germination, is the best turf type for the cold temperatures of dormant seeding. It germinates best when temperatures are below 35°.

How Late Can You Seed?
20-30 days before first expected killing frost is safest. Ideal soil temp for fall establishment is 73-76° at a 4” depth. It is risky to seed later, and you may run into the Suffolk County Fertilizer Blackout Law, which could prevent follow up fertilizations that make healthier establishment possible. The old rule is: Seed by Labor Day, you’ll be ready for play by Memorial Day. Every week seeding is delayed beyond Labor Day costs two weeks of full turf use after Memorial Day.

RENOVATION: SEED AND SOD
The best time of year to renovate is late August through mid-September.

1. Do not bring in soil from a remote site. It causes layering/drainage issues or cement-like soil as finer particles mix with larger.
2. Never use sand to amend clay or clay to amend sand. Work with soil you have and improve it with organic matter.
3. Reserve power equipment in advance.
4. Have soil amendments like compost on hand or delivered in advance to get a pH.
5. Get a pH of existing topsoil so you know how much lime to amend with, if any.
6. A final pH of 6.3-6.8 is crucial for soil structure and nutrient uptake by grass.
7. Do a phytotoxicity test on compost by attempting to sprout cucumber seeds in several small pots: some of compost, some of soil you know has no problem. If seeds sprout, turn yellow, and die before developing true leaves, your compost has problems; possibly too much salt.
8. If you have limited time, rent a sod cutter to strip off old turf for disposal. Set sod cutter on lowest setting to get as much of old root system as possible.
9. Once you have removed old grass, spread organic amendment on surface, using 2-3” depth of material, or 6 cubic feet per 1000sqft of lawn area.
10. Spread starter fertilizer on soil, using 40lbs of 5-10-5 or 5-10-10 NPK or its equivalent per 1000sqft. Spread lime as recommended by your soil pH test.
11. Fire up the rototiller. Plow organic and other amendments in to a depth of 6-8”.
12. Do not over rototill. This will break down soil structure and cause compaction and drainage problems. You want soil clumps the size of a pea to the size of a golf ball.
13. If you have a slope, don’t plant it to grass. Install a low-maintenance ground cover.
14. Holes/dips in landscape should NOT be filled in with pure organic matter or topsoil brought in. Instead, mix equal parts organic matter and topsoil shaken from turf removed from your site and use this mix to fill in depressions.
15. Rake seedbed to remove root clumps and stones over 2”. Rake again to smooth.
16. Apply a light fertilization, about 1/3 amount applied prior to incorporation of amendments.
17. Put seed in freezer for 48 hours to crack seed coat and halve germination time.
18. Allow bed to settle for 24 hours.
19. Rake a final time for levelness.
20. Seed with a mix of grasses appropriate for your site, at rates appropriate for the type of grass you have selected.
21. Divide seed mixture in half. Sow each half in opposite directions for good overlap.
22. Compensate for unviable seed by calculating the pure live seed rate.
23. Mulch with straw to conserve moisture around seed. Use 1½ bale of straw/1000sqft. You will not need to remove this unless applied too thickly. (Don’t use hay; it contains a lot of weed seeds.) You should see 50% bare ground, 50% straw.
Watering
This is one time light, frequent waterings are recommended. (Mature turf is watered differently.) Make sure waterings are gentle; seed is easily washed away. Initially water to a depth of 5-6”, then lightly several times a day. Maintain until grass is at least 1.5” long!

TIP: Light and frequent means, enough to keep the upper 1” of soil moist. You can decrease irrigation to once a day at the level of 0.25” depth of water once turf is 2”. Maintain this level for 3-5 days. THEN skip a day between irrigations, applying 0.3-0.5” depth of water to wean the turf off light frequent irrigation. Do this for 1.5-2 weeks, and then continue to provide deep, infrequent irrigation as you would for mature turf.

Turf Renovation Continued
When grass height reaches 4”, mow it back to 3”, and weekly after that. Poor mowing practices after renovation are a major reason for failure. Most wait too long to mow!

For maximum establishment, fertilize with: 0.5-0.75lbs N/1000sqft, 4-6 weeks after seeding.

TIP: The year after establishment, if you use:
No phosphorous, low N formulation: Make sure K is also very low, or you will have less growth.
No phosphorous with moderate to high N: K level does not matter.
No phosphorous with very high N: Get more growth with more K.

The "Don’ts“ of Turf Renovation
People love to top existing soil with a 1-2” layer of sand, organic matter, or loam in an effort to improve their lawns. This practice rarely succeeds, and can result in a layering effect that impedes water and fertilizer movement into soil, and restricts grass’ ability to root. Avoid skid steer renovation, it causes compaction. When water hits seed on compacted soil, it follows the path of least resistance, causing spotty take of turfgrass seed, and rivulets of bare soil with sand on top where crabgrass will thrive.

INSTALLING SOD
Prepare sod bed the same as seedbed. The worst mistake you can make is to lay sod over existing turf, or to only scratch the area lightly; you are asking for sod not to take. You MUST core aerate 4-6 weeks after installation to provide a channel for roots to get beyond the soil on the sod at installation.

Most sod is grown on fine textured soils, so when placed over sandy soils, you get a perched water table and sod roots rot. Core aerate 4-6 weeks after installation, when sod gets to a root depth of 2” to reduce risk of layering. When installing sod you still need to incorporate pre-plant fertilizer, then starter fertilizer. Follow the seeding regimen! Lightly roll sod with an empty roller to get rid of air pockets that later become dead spots.
Looking ahead:

- Sod will root in 1-2 weeks, and must have rooting depth of at least 4” for play.
- New sod needs at least 1” of water 30-minutes after installation. Soil beneath should seem sopping wet. A screwdriver barrel should have moisture at least 4” along it; if not water more.
- Keep soil wet for at least two weeks after sodding.
- For 0.25”/day or more, perform light and frequent irrigation; sod roots are short.
- Until roots grow down, use a screwdriver barrel to confirm water is penetrating beyond the layer of soil brought in on the sod. Push screwdriver through sod, into soil about 4”. It should travel easily into the soil. When you pull the screwdriver out, you should be able to feel moisture along the first 3-4” from the blade. Use this technique as sod roots or as you water other plants to determine how deep water is going.
- Dry areas are likely to occur at corners, edges, and around buildings due to reflected heat and poor irrigation distribution. You may need to hand water these areas.

TIP: If water runs off rather than continues to soak in, shut down water, wait 30 minutes, and resume. You may have to do this several times depending on slope and soil conditions.

You will need to provide LIGHT FREQUENT IRRIGATION FOR APPROXIMATELY THREE WEEKS until sod has rooted below a depth of 1.5”. Water several times a day, at about ¼” depth. Determine how long you need to reach ¼” with an inexpensive rain gauge to measure irrigation system output. If conditions are arid or windy, you may have to water more frequently to prevent sod from drying out.

SOD SURVIVAL TIP
If temperatures are 90° or higher, or if there is high wind for more than half the day, set sprinkler system to go off multiple times between 11AM and 2PM to provide a light sprinkling in addition to regularly scheduled watering. These light sprinklings are designed to cool off the crown of the grass by evaporation in order to prevent “heatstroke” in the turf, which really means keeping the crown cool so no permanent damage occurs.

DEALING WITH GRUBS
By the time you see damage, reseeding is the best option.

How Should You Fertilize if You Have Grubs?
Heavy nitrogen fertilization in spring and summer will decrease root growth, increase turf stress, and accentuate damage caused by grubs during September and October. Use of milorganite fertilizer at this time of year may also deter grub predators.

For turf attacked by grubs, spoon feeding with liquid fertilizer may the best option. It is easy to flush nutrients past roots that are very short and damaged. Small amounts of liquid fertilizer have a better chance of being taken up to help with regrowth.

Try feeding at the rate of 1/8lb per week for 8 weeks, (or until the fertilizer law blackout point has been reached), or ¼lb every two weeks for 8 weeks, or until roots have grown back. Avoid high salt fertilizer; this will make the potential for physiological drought around the limited roots worse. Avoid heavy nitrogen, fast-release products; you will push top growth that cannot be supported by the limited roots.
How should you irrigate if you Have Grubs?
Irrigation during drought periods in August and September will usually reduce turf damage caused by grubs, whereas frequent irrigation in June and July can attract egg-laying females and increase egg survival. Withhold irrigation as much as possible in June and July. If grub damage occurs in late August and September, water frequently. If grubs are present, you may have to combine light, frequent irrigation with deep, infrequent irrigation for “hydroponic turf.”

When grubs attack the root system of turf, its ability to absorb water and nutrients is reduced, leading to turf losses. Proper irrigation can provide enough moisture for survival, even with a reduced root mass. This is why irrigated turf can tolerate higher numbers of grubs per sqft than unirrigated turf.

Consider using wetting agent; chewed up turf tends to get hydrophobic as does soil underneath.

A grub hit watering regimen should be light, frequent irrigation. Treat the area like a newly seeded or sodded area. Light, frequent waterings must continue until grass roots are at least 1.5” in the sodded area. Water enough to keep the upper 1” of soil moist. You can decrease irrigation to once a day at the level of 0.25” depth of water once turf no longer lifts easily by hand. Keep this level up for 3-5 days, THEN skip a day between irrigations, applying 0.3-0.5” depth of water to wean the turf off light, frequent irrigation. Do this for about 1.5-2 weeks then provide deep, infrequent irrigation as you would for mature turf.

Is There a Link Between Soil pH and Grubs?
Make sure soil is not in acid range. This can encourage grubs or make grass less able to withstand them. Grubs average 2.2-6.0/sqft at a pH less than 5 vs. 0-0.6/sqft in neutral to alkaline soils. Make sure fertilizer is not sabotaging liming efforts by making the soil more acidic.

What are the Best Management Practices for Reducing Grub Damage?
Establish tall fescue turf. Although grubs feed on the roots, it is seldom damaged. During the mid-August and September feeding period, tall fescue usually is able to replenish its root system at a rate sufficient to counteract grub feeding. During the same feeding period, Kentucky bluegrass roots are NOT re-growing.

Reduce heat during a grub hit. Your turf has a limited root system with a grub attack, so it is essential to keep damaged areas cool. Help keep crowns viable through the limited ability of roots by artificially cooling them with syringing or wetting agents to help spread water. You can also use straw at a rate of 1 bale/1000sqft, it helps to trap and hold moisture. Again, you are treating the damaged turf like a newly sprouted seedling until the root system can regrow. 1/8” compost top dressing can be used to hold moisture and to mulch crowns. Or, use an artificial “pontoon” to keep water ponded in the area of damage (Looks like the draft doggie for the bottom of doors in winter.)

Scout for grubs. The area at greatest risk has more than 60% Kentucky bluegrass and less than 30% shade. The threshold for grubs is 8-10/sqft. Well-watered turf can cope with 30/sqft. Grub distribution is spotty, so sample in a grid pattern with about ten paces between shovelfuls. If there are two consecutive shovelfuls with a grub(s), it is a hot spot for further sampling.
Nematodes, Chromobacter subtsugae and Milky Spore
The best time of year to apply entomopathogenic nematodes is mid-August through end of September. When it is hot and dry, grubs will move 4-8” deeper into the soil profile so apply $\frac{1}{2}''$ of irrigation before applying nematodes and then $\frac{1}{2}''$ after applying nematodes. This encourages grubs to move back into the root zone and moves nematodes down into the soil zone where the grubs are for better contact and efficacy. Commercial milky spore is ONLY for Japanese Beetles; we have mostly oriental beetles on Long Island. To use milky spore for Japanese Beetles, use 1tsp on 4ft centers. Chromobacter subtsugae (Grandevo) should be applied to first instar August 10, and to second instar August 21.

DEALING WITH CHINCH BUGS
Chinch bugs are tiny true bugs that suck turfgrass juices with a straw-like mouth part. A chinch bug has a triangular head and bright red eyes. The adult is about the size of a sesame seed, 1/5” long, with a black and white X pattern on the back. Adult chinch bugs are inactive during the winter. Reproduction begins after the appearance of warm weather in spring. Juvenile chinch bugs look like tiny bright orange and white candy corn.

Chinch bug saliva is toxic to the turf. Damage looks like disease or drought injury, and can develop rapidly, especially in sunny locations during hot, dry weather.

First signs of chinch bugs:
- Expanding, irregular patches of dead/stunted grass surrounded by halo of yellowing, dying grass.
- Lots of starlings feeding on turf.
- Grass turns yellow to red-brown, looks drought stressed but water doesn't help.

How can I find out if I have chinch bugs?
- Part grass on margin of where it is damaged and still green; inspect leaf litter for presence of larvae and adults.
- Remove both ends of 1lb coffee can. Pound can about 1” into ground between damaged and green grasses. Fill with solution of one gallon water + one ounce lemon dish detergent. If can drains, fill again. Wait 10 minutes for chinch bugs to float to top.
- Use watering can to apply water + detergent solution to margin between damaged and green grass in 2sqft area. Lay sheet of white flannel on top. Wait 10 minutes or so, then peel back the flannel and look for chinch bugs clinging to underside of cloth.

Start to sample at 115 GDD (growing degree days) and again at 850 GDD.

Chinch bugs like all grasses. Often the greatest numbers will occur in weedy lawns with lots of bents, fescues and thatch. They favor full sun, and all but northern slopes or faces. You are most likely to see damage in June with droughty conditions.

The best option for chinch bug reduction is to overseed with endophyte enhanced grasses in fall. Endophyte enhanced grasses have a fungus that grows within the grass plant and can reduce and eliminate chinch bug feeding after several consecutive overseedings. Ryces and fescues can be purchased with endophytes.
**What is the Threshold for Treating Chinch Bugs?**
The threshold is 15-20 chinch bugs/sqft. More than 20 floaters/coffee can means action should be taken to avoid loss of turf.

*Visual Threshold:* More than 10 chinch bugs found in a 60-second search of 1sqft and 20-30/sqft in a detailed search.

**Why Would Chinch Bugs Show Up in Different Places Each Year?**
Heat accumulation can change from year to year. Extra heat means a greater chance for chinch bug problems.

Heat accumulation can result from:
- Sand top dressing
- Pavement edging
- Loss of shade from tree or shrub removal
- Dethatching
- Pavement changes
- Reduced mowing height
- Use of different equipment that radiates more heat.

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**Monitoring Tips for Turf Insects**
- 1 ounce of lemon soap in a gallon of water sprinkled onto surface of turf should bring insects to surface in 5-6 minutes, provided sample area has been mowed low.
- Starlings are an indicator of caterpillar pests.
- Tiny tufts of grass pulled out are an indicator of insects in turf.
- Dead patch with yellow border, soil firm, in sun: chinch bugs.
- Dead patch without yellow border, soil firm, in sun: caterpillars.
- Dead patch, loose, soil spongy, in sun: grubs.
- “Pencil-holes” in turf: caterpillars or bird pecks.
- Mounds with granular materials: ants or worms. (turf damaged but not discolored)

**Weather Considerations for Turf Insects**
- Cool wet springs: Natural fungal epidemics in turf insects.
- Hot dry weather: More chinch bugs, may decrease grubs, or grubs may show up later.
- Warm spring: Caterpillar pests may show up earlier than usual.
- Cool summer: Late blooming grubs.
- Worst case scenario for grubs: Hot dry summer and fall, followed by cool wet spring.
- Dry conditions also reduce the natural spread of caterpillar diseases.

**Watering Considerations for Turf Insect Management**
- Grubs move 4-8” DEEPER when hot and dry.
- Water top 2” of soil (0.25-0.5” volume) 24-36 hours prior to treating, grubs move back into root zone, thus better contact and efficacy: VERY IMPORTANT FOR NEMATODES.
- Water AGAIN after treatment to keep grubs in root zone.
- 1” volume = 622 gallons of water/1000sqft.
- Caterpillars are at surface; don’t push treatment beyond where they are.
- Caterpillars are nocturnal, so delay putting treatment out until early evening.
**INDICATOR WEEDS**

- **Low soil fertility**: Cinquefoils, common mullein, mallow, moss, wild carrot
- **Low nitrogen**: Chickweed, clover species
- **Too dry**: Bird’s foot trefoil, crabgrass, quackgrass, silvery and other cinquefoils, rabbit foot clover, pigweed, speedwell, leafy spurge, prostrate spurge, yarrow, yellow wood sorrel, goosegrass, curly dock
- **Too wet or poor drainage**: Algae, (also indicates pythium root and crown), nutsedge, barnyard grass, rushes, false green kylinda, smartweed, creeping bentgrass, buttercups, corn chamomile, coltsfoot, docks, lady’s thumb, plantains
- **Mowing too low**: Annual bluegrass, chickweeds, speedwell, moss, creeping bentgrass, purslane, crabgrass, dandelions, ground ivy
- **Shade**: Moss, mouse ear and/or common chickweed, creeping speedwell, violets, ground ivy
- **Compaction**: Prostrate knotweed (with bluish green leaves), goosegrass, pineapple weed, corn speedwell, annual bluegrass, broadleaf plantain, prostrate spurge, aujuga, moss, chickweed, crabgrass, ground ivy, pineapple weed
- **Excessive surface moisture**: Algae, moss, creeping bentgrass, annual bluegrass, cinquefoils
- **Low pH**: Moss, sheep sorrel, rabbits foot clover, coltsfoot, docks, English daisy, wild strawberry, hawkweeds, knawel, lady’s thumb, common mullein, wild parsnip, wild radish, foxtail spp., mallow

**DANDELIONS**

Dandelions are effective competitors with turf when:
- Turf is mowed low.
- Calcium levels are low.
- Fertility is low.
- pH is out of whack.

Increase calcium levels via gypsum or other to reduce dandelion and other weed competition if calcium soil test levels are low.

Since Dandelions effectively out-compete grass at LOW nitrogen, look at your fertility program or other factors that may be affecting nitrogen availability (such as pH). Avoid fertilizers with excess potassium, especially if you apply more than what your soil test recommends. Long-term studies in the United Kingdom found potassium fertilizers increased dandelion densities up to twenty-fold.

Ironically, excess potassium can also increase snow mold disease exponentially, yet many biostimulants are particularly rich in potassium. Use your soil test as a guideline for applications and pay attention to potassium levels in both location and in products.

Seed germination occurs at or very near the soil surface. Light increases germination. Beware dethatchers, scattering cores from core aeration, and disturbing the surface in spring! Dandelions are suppressed by mulch mowing in fall.
CRABGRASS
Crabgrass seed contains a pigment that stimulates germination when exposed to light and heat. Crabgrass is a warm season annual grass. If cool season grasses are present, they will have already established when crabgrass germinates.

This tells us three things:
- We do not want to expose crabgrass seed to heat or light.
- We do not want gaps in cool season turf where dark, bare soil can absorb heat and light and allow crabgrass to get going.
- Crabgrass, a warm season summer annual, will out-compete cool season turf during warm weather by virtue of its tolerance for heat and drought, and by occupying hot compacted areas like the edges of lawns, near concrete, by the side of the road, etc.

Steps to take in an organic program to reduce crabgrass and its competitive behavior:
- Make sure spring turf is thick as it can be, and any bare spots are dormant seeded to avoid open gaps for crabgrass.
- Stop edging lawns, this exposes crabgrass seed to heat and light, while damaging, desiccating, and overheating turf crowns and roots.
- Apply slow release fertilizers early; second to third week of April, so they have time to be released by warming soil microbial activity, to be most useful to turf and least useful to crabgrass. Waiting until late May means, by the time nutrients are released, cool season turf is shutting down for summer, leaving crabgrass to use all the nutrients.
- Make sure areas of heavy crabgrass activity are renovated in fall; otherwise dead crabgrass will weather away over the winter leaving a large bare area of soil with crabgrass seed on top just waiting for spring sun.
- Do not core aerate in spring and then break up and scatter cores across the surface; you are scattering crabgrass seed right where it wants to be. The same is true for using dethatching machines.
- Make sure irrigation practices are not contributing to crabgrass issues. Light frequent irrigation encourages turf thinning because of dry zones that develop deeper in the soil profile. This thinning encourages crabgrass, as does over watering. The naturally shallow root system of crabgrass is not affected by constant saturation.
- Make sure mowing height is at least 3”. The lower the height, the shallower the root system, the hotter and often drier the site, and the more potential for crabgrass germination and take over. In one study, 6-8 weeks AFTER forsythia flowers begin to drop, crabgrass was reduced by 50% by increasing mowing height to 3.5-4”.

TIP: For cracks and crevices in driveways, sidewalks, and tennis courts, or where you feel you must edge, install a line of felt weather stripping by pushing the felt in tight to the cracks or against the edged turf. Water to help settle the stripping.

This will prevent crabgrass seed from germinating and the areas from filling in with crabgrass at the rate unprotected sites would experience. The felt is biodegradable, and keeps edges of turf moist and protected from the reflected heat and dryness of the sidewalk.

WILD ONION AND WILD GARLIC
Frequent, low mowing early in spring before grass has broken dormancy can help to severely weaken the plants. Never allow aerial bulblets to form; they will shatter and spread everywhere.
UNDERSTANDING ANNUAL BLUEGRASS

Typical Annual Bluegrass Cycles: At the first dry spell in spring, overnight there are yellowing pockets of grass with seedheads. A few weeks later, their dead space is taken over by crabgrass. Even though there is technically an annual and a perennial biotype, all annual bluegrasses are considered winter annuals. This is important from a control standpoint. Winter annuals’ seeds germinate in late summer and fall. That means the plants mature in fall and live through winter. Seed can live for up to six years in the soil.

Conditions
Weather: Annual bluegrass is quite susceptible to winter damage and may be killed by direct freezing of the crown, and by extended periods under ice cover. Annual bluegrass ALSO invades any opening in the turf. So if you have a bad winter, and the annual bluegrass is killed or thinned leaving an open space, crabgrass will happily fill in any gaps. If moisture dries up in late spring causing annual bluegrass to die out, crabgrass again has the advantage because it is tolerant of such conditions.

Aerification: Time aerification and plug scattering wisely. It is important to NOT drag cores back in spring. You will drag crabgrass seed and annual bluegrass seed over the surface where it can take advantage of the extra light to stimulate germination. The peak germination period for annual bluegrass in most regions is late summer and fall, which means aerification in mid to late August will ALSO bring seed to the surface for germination.

Irrigation: Irrigation frequency and depth of penetration can either encourage or discourage annual bluegrass. Annual bluegrass has a very shallow root system so it prefers wet conditions, especially if it can live in a lens of moisture caused by surface compaction. Light frequent irrigation and over watering on compacted soil encourages annual bluegrass. Withholding water until desirable turfgrass species exhibit initial drought stress symptoms can help reduce soil moisture for potential annual bluegrass infestations. It is especially important NOT to over water early in season to discourage annual bluegrass. Over watering, especially in shady areas, may predispose the site to annual bluegrass invasion.

Fertility: Discourage annual bluegrass by keeping phosphorus applications LOW, allowing mature turf to take its phosphorus from underlying soil. Annual bluegrass may also be encouraged by high nitrogen levels. Fertilizing dormant turfgrasses when annual bluegrass is actively growing may also exacerbate infestations and should be avoided. In fact, nitrogen fertilization should be reduced during peak annual bluegrass germination and periods of vigorous growth.

Unfortunately, peak germination occurs during late summer and fall; the timeframe most important for fertilizing desirable turf species. The best option is to use slow release products with moderate nitrogen levels so annual bluegrass is not favored. High nitrogen at these times encourages annual bluegrass spread and survival into winter and spring. In addition to limiting P application, applying sulfur to acidify soil is suggested to decrease annual bluegrass density. However, acidification can favor undesirable bentgrass, so manipulation of fertility plus other cultural connections may be a better bet.
**Mowing:** Low mowing (especially in condominium common areas), coupled with high irrigation, high fertility, and compaction is a recipe for LOTS of annual bluegrass. As previously mentioned, annual bluegrass has a strong light requirement for seed germination compared to Kentucky bluegrass and creeping bentgrass. Thus a dense stand of turf which shades the soil surface is capable of preventing annual bluegrass seed germination and invasion. This means, simply, **mow high for less annual bluegrass.** In areas of high concentration of annual bluegrass, collecting clippings with seed heads during seed head formation is also a management strategy until changes can be implemented to the site or to cultural practices.

**Compaction:** Renovation, especially with skidsteers, can result in focal compaction in multiple areas; conditions perfect for annual bluegrass takeover. Water applied to a compacted renovation site follows the path of least resistance, leaving fingers of heavier sand particles behind, plowing smaller particles into little humps over compacted soil where annual bluegrass will thrive. Look for fingers of bright green surrounded by fingers of crabgrass or poor growth.

**Thin Turf:** Openings in the turf from disease damage, divots, or similar adverse stress conditions will permit light penetration to the surface. The result is rapid germination of existing annual bluegrass seeds followed by seedling growth and invasion of the area.

**TIP:** Seed with 50% more than recommended for dormant seedings in shade and other areas to compensate for rot and bird predation, or annual bluegrass may fill in these areas. In consistently wet soil, fine fescue will not grow, and annual bluegrass will take over.

**UNDERSTANDING BENTGRASS**
Bentgrass grows differently from other cool season turfgrasses. Its growth point is much closer to the ground, allowing it to be grazed or mowed very low with less damage. When mowed at the proper height for other cool season turfgrasses (2.5-3”), some varieties develop a long stringy stem with a witch’s broom of green growth at the top. This growth habit often causes the grass to flop over and form what almost looks like a crop circle appearance. Other varieties of bentgrass will also flop over, particularly during periods of high heat and humidity, when often the bent will appear to die out altogether each year during the summer.

Bentgrass is highly competitive in wet areas, like the bottom of slopes / swales, in the shade / along shade lines, in seaside areas, and in wet areas that are compacted. Bent was once included in seaside grass seed mixtures due to its tolerance of these conditions. The seed is extremely fine, allowing it to blow in from adjacent areas as a contaminant.

Bentgrass tolerates acid soil better than other cool season turfgrasses. Making sure pH is between 6 and 7, ideally 6.3-6.8, can help other grasses be more competitive.

The design of a property is also important, for instance, if wind is blocked on three sides and thus holds in moisture, bent will thrive. If the site is extremely wet and this is contributing to the problem, cut back on irrigation. Try twice a week at only 0.5” at each application, between midnight and 8AM. You can also install more dry well drainage to pull water out of swales. A sod cutter can be used to cut out contiguous areas of bentgrass.
UNDERSTANDING NUTSEDGE
Nutsedge is not a grass.
- It has three-sided leaves and stems and is often found in wet habitats.
- It can be introduced to a site in compost or by birds.
- Nutsedge particularly likes light, sandy soils with high moisture.
- In turf, it grows more rapidly than desirable grasses and is readily apparent 2-3 days after mowing.
- Hand removal is laborious, expensive, and usually unsuccessful due to buried tubers, unless soil is removed to a depth of 3 ft and replaced with tuberless soil.
- Since most reproduction is by means of tubers rather than seeds, control should be directed at tuber management.
- Since tuber production is correlated to light, increasing shade by as little as 30% can promote a corresponding drop in tuber production, although it never stops it completely.

If you want to dig out the nutsedge before more tubers are produced, early spring is best. Start about 10” away from the perimeter of the problem and go 10” deep. Refill area with clean soil.

Once again, watch that irrigation!
- Drainage is a best bet for containment.
- Monitor irrigation systems; a sudden surge of nutsedge in an area that has not been disturbed recently and has never had nutsedge before might signal a break in the irrigation head or line.
- Cultivation can help to control nutsedge outbreaks in areas where it is practical, and before plants have reached the 5-7 leaf stage. Shallow cultivation permits desiccation but is not a sure cure.
- Cultivation should NOT be done when soils are wet, moving wet soils contributes to spread.

QUACKGRASS
Quackgrass is easily identified, as it is the only perennial weedy grass that spreads by rhizomes.
- It is very salt tolerant, so hot, dry sites exposed to deicing salts or overwash are particularly vulnerable.
- Using organic contact herbicides on quackgrass is problematic because up to 95% of lateral buds on the rhizomes are dormant, though the plant is actively growing. After about 7 days, the dormant lateral buds will start to grow new shoots.
- It may take more than one application of organic herbicide to completely eradicate quackgrass.
- Nitrogen fertilizer will break lateral bud dormancy. The plant will begin to poke up again, and you can now use your contact product to exhaust the quackgrass’ reserves.

Using this strategy to exhaust the plant may be particularly effective during springtime. Rhizome carbohydrate reserves are quickly depleted in spring as rapid shoot growth occurs.

ALGAE
Surface algae is usually a sign of a lens of compaction just below the soil surface on which moisture sits and warms, allowing algae to proliferate on the surface. The resulting semi-anaerobic conditions are perfect for pythium root and crown infection and in fact the dark, slimy presence of an algae layer almost always goes hand in hand with the disease. Reduce phosphorous fertilizers and aerate to break through the layer, and avoid sand top dressings.
CLOVER
Dry conditions a previous season enhance clover germination in the current season. White clover can access nitrogen from the atmosphere, making it very successful where turf is thin from poor fertilization. Dry conditions in fall mean poor fertility utilization and thin lawns in spring. Clover therefore has niches to occupy, and a germination advantage.

- Clover begins to germinate in fall when soil temperatures are 50°-60°. Germination continues throughout winter and early spring.
- Clover seed has a hard, heat-tolerant seed coat. Composting and solarization are not as effective in reducing its seed viability as they are with other weed species. The hard seed coat also allows seeds to survive longer in soil than many other weed seeds; clover seeds can germinate over many years, making control an ongoing effort.
- White sweet clover germinates at minimum 41°, but the best germination occurs when soils are 64-68° degrees. Spring is the optimum time for germination. White clover requires moist soil and cool ambient temperatures.

If you WANT clover: Do not fertilize or seed in thin areas of turf in spring. Clover is beneficial for its nitrogen fixing abilities and its pollinator friendly flowers.

If you do NOT want clover: Change your fertility or fixing soil so nitrogen is optimally available, and overseed turf so it is not thin.

SPRING SEEDING TIP: Seeding in spring is dicey because of competition from summer annual weeds. If you have to do it, research has shown seeds applied just before soil temps reached 50° provided 20% more cover by mid-June for Kentucky bluegrass, and 10% more for perennial ryegrass. Tall fescue prefers warmer temps, spring seed in late May or early June. Newly seeded areas need water until there is at least 60-70% cover.

MOSS
Moss tends to occur in areas that are: thin, disturbed, have low fertility, are salty, are compacted, have acidic soils, have endured an oil spill, and/or are shaded.

Mosses thrive in areas of: turf injury from disease, insects, chemicals or cultural practices, especially dethatched areas.

Repeated dethatching can encourage moss populations from year to year. Fertilizers that acidify the soil, or turf areas with naturally acidifying additions like pine needles or oak leaves will be subject to moss. Moss is more likely in areas of soil with potassium deficiency, with high calcium to magnesium ratio, or on heavy soil.

Controlling Moss:

- Two applications of a soap product labeled for moss control, two weeks apart, generally achieves a high level of control. Excessive damage may occur to turf if soap applications are followed by frost. To minimize turf scorching after soap applications, rinse turf within an hour of application.
- Moss can also be removed by using a sod cutter.
- A simple change in pH to 6-6.5, and to a less acidifying fertilizer, plus passing on dethatching, may make all the difference in permanent moss reduction.
TURF DISEASES

Damping Off: Death of seedling turf caused by fungus, before or just after it has sprouted. Damping off can kill seedling turf virtually overnight.

Pre-emergence damping off: Occurs prior to new plant breaking through soil, meaning, the seed actually rots.
Typical damping off: The stem and roots form, but the plant is girdled at the soil line. The seedlings yellow, the plants become floppy, and the whole stand of new grass collapses and dies, often with a bunch of fungal threads visible in the canopy. This is seen more often than pre-emergence damping off.

Both types of damping off are favored by a poor seedbed:
- Too wet.
- Seeds planted too deep. (never plant more than 1/8”)
- Too much fertilizer applied.
- TOO MUCH SEED! When you spread seed thickly, you set it up for high competition for light, (leading to spindly plants with thin cuticles), and you increase humidity leading to rot and extreme competition for water and nutrients.
- Soil should be fine and firm.

All of this leads to weak grass, and opportunistic diseases are going to move in. Typical damping off organisms are the same that produce disease in mature turf, e.g., Pythium, Fusarium, and Rhizoctonia, and they stick around from year to year.

The most important thing is proper seedbed preparation:
- Freeze seed pre-planting for 24-48 hours to crack the seed coat and speed germination. This gives an advantage over fungus-induced pre-emergence damping off in cool soils.
- Fertilize with a 1/2lb actual nitrogen/1000sqft in the form of starter fertilizer about 4-6 weeks after establishment.
- Water in AM and early afternoon so soil can dry before nightfall.
- Mow as soon as seedlings reach a mowable height to keep canopy drier and less humid, less conducive to damping off.

Pythium Root Rot (on seedling turf AND mature turf)
- Can I see it with the naked eye? No.
- Is it obvious? No.
- What kinds of grass get it? Bluegrasses, bents, rye.
- What kind of weather? Cool, wet. (Pythium blight occurs in hot, wet weather).
- What do I look at first? The entire turf stand, the roots, the soil to a depth of 6”.
- What do I see? Thin, off-color turf, yellowed areas, roots short and off-color in areas of poor drainage and shade, or in low spots near surface water. If soil has been amended with topsoil or sod laid you may have what look like two or more discrete layers. This can make for very poor drainage and predispose turf to pythium root rot. Wherever you see algae growing on surface of soil or grass, you are likely to see pythium.
- What do I do? Don’t over irrigate! Improve air circulation and drainage. Use slow release fertilizers, avoid excessive watering, avoid compaction, top dress with compost. Amend with composted poultry litter.
- Will the grass die? Yes. The pathogen attacks the roots.

The problem is largely cultural due to poor drainage. Fixing the drainage problem should eliminate fungus issues. Another fungus is available as a biological control for pythium.
Dollar Spot: If you have dollar spot issues on your lawn, mow the good area first, then the bad. If you mow lawns commercially, mow them early and wash down mowers prior to moving on to later lawns. Any afternoon or evening watering must be changed. You can also set irrigation systems to syringe early every morning (4AM) to knock guttation fluid off. Dew removal between 4AM and dawn can provide 70-80% reduction in dollar spot severity.

Look for the disease from April through December. Conditions are perfect for dollar spot when there is heavy dew, extended leaf wetness, temperature bounces, and nitrogen runs out. (When disease begins it is a signal to FERTILIZE!) Dragging to remove dew is just as good as fungicide, and mowing is just as effective. Rolling also helps dry things out. Wetting agents for dew and guttation management work well, and get mowed off in 7-10 days. Make a couple of wetting agent applications in hot spots to control dollar spot without fungicide.

Endophytes help to decrease dollar spot by enhancing vigor, but this only helps in areas planted with fescues or rye. Biocontrols can be used with low disease pressure but require multiple applications. Dollar spot is capable of producing root-inhibiting toxins. Combined with high salt fertilizers, you have a recipe for turf disaster. The high nitrogen in the fast release salt fertilizers encourages juicy top growth, which attracts dollar spot. The salts coupled with toxins difficult to break down in soil spell disaster and failure for roots. Dollar spots take FOREVER to grow out, PLUS there is always new inoculum moving in. This leaves a depression in turf ripe for moss if grass is in shade, compacted, or acid conditions; and for crabgrass if it is in the sun.

Dollar spot can develop during late spring/early summer or late autumn, but early autumn drought brings the severest outbreaks, especially when salt is involved. Salt build-up in SPRING will probably be found in the area driest the previous fall, or where nutrients were run off or washed through, or where salty snow was piled up. This is where you will likely see your first outbreaks.

Drought-stressed turf is particularly susceptible to infection but free water, high relative humidity, and/or heavy dew is necessary for disease development. WATCH OUT FOR FERTILIZER TO RUN OUT THIRD WEEK OF AUGUST: this is correlated with a dollar spot jump. Temporary drought stress during the day will make grass more susceptible to dollar spot!!

### Dollar Spot
- Can I see it with the naked eye? YES!!
- Is it obvious? Yes!!
- What grasses get it? Bents, bluegrasses, rye, fine fescue, Zoysia. (Can be very severe.)
- What kind of weather? Warm temps, high humidity, cool nights, persistent drought.
- What do I look at first? Leaves.
- What do I see? Hourglass shaped spots with brown edges, irregular straw-colored patches, tip blighting, “cobwebs” on lawn in AM (actually fungal threads), dime-quarter sized pits in low mown turf. Do not confuse with ball marks.
- What do I do? Reduce compaction, raise mowing height, DO NOT water late afternoon and evening, avoid light frequent sprinkling, reduce shade, increase air circulation, use natural organic fertilizers, animal and plant meal amendments.
- Will the grass die? Yes. Fortunately, only small areas are usually affected initially. May cause decline of new roots.
- Dollar spot is easily spread on mowers, shoes, and other objects.
**Summer Patch:** Root pathogen that sets up infection where it penetrates the roots. Poa annua shows earliest symptoms of root dysfunction, because it already has such a shallow root system.

Summer Patch presents first in areas the size of a basketball, (if the area is larger, it is often something else), BUT BASKETBALLS WILL COALESCE. There may be “frog eyes” of green grass surrounded by a tan ring, or serpentine swirling tan patterns in the turf. Kentucky bluegrass is favored as a host. The summer months are most common for visible symptoms.

To test for Summer Patch, take a sample and incubate in a sealable bag on a sunny windowsill:

- Summer patch makes no fuzz.
- Rhizoctonia (brown patch) fuzzes mid-canopy or on top of the sample.
- Fairy ring fuzzes on the side.

Roots begin to be infected about mid-April, but symptoms do not appear until it begins to get hot and dry, and damaged roots can no longer pull water up through the plant to keep the crown cool.

- Mow at 3.5” to reduce visible disease symptoms.
- Reduce pH to 5.5 to 6.2.
- Ideal pH for significant reductions in disease is 6.0 in the upper 2”of soil, where fungus is most active.
- Every 1/10 of a pH unit drop below 6.5 provides some reduction of summer patch.
- Avoid nitrate nitrogen or urea.
- If you are going to skimp on fertility, do it early in season.

**Companion biofungicide (Bacillus subtilis) is excellent for summer patch.**

- Start treatment with Companion EARLY to control the disease: apply mid-April through Labor Day.
- Put Companion in 5 gallons of water per 1000sqft, so it gets drenched into root zone but not pushed beyond.
- Trim grass back to 2” before treating and apply just after mowing so you have a ratio of more product to less surface area.

**Manganese deficiency will make the disease worse.**
Add 6-8lbs/acre/year using manganese sulfate. This also helps to drive pH down to 5.5-6. You may need to do this yearly, since the disease actually metabolizes manganese.

**Syringing**

- Syringe newly planted areas susceptible to summer patch if temps approach 80º, or if there are high winds for more than half the day under hot, dry conditions.
- Syringing does NOT replace regular irrigation, just cools turf down to reduce desiccation and root death from heat accumulation.
- Syringing can reduce temperatures 1-2 degrees for up to 2 hours, so it is a crutch to get through a hot day.
- Syringe areas that have the most abrasion. Summer patch usually occurs in the hottest part of the lawn.
- Look for roots that are tan and brittle.
**Summer Patch**
- Can I see it with the naked eye? Possibly.
- Is it obvious? Possibly.
- What grasses get it? Bluegrasses, bents, rye, fine fescues.
- What kind of weather? Infection occurs in cool, wet weather. You won’t SEE symptoms until it gets hot and dry, and grass is stressed. Less likely in cool, wet summers.
- What do I look at first? The turf stand in general and the roots.
- What do I see? Look for wilting, frog eyes, swirls, or browned out areas in hottest part of lawn. Roots will be tan or brittle. Grass will change color from wilted blue, to reddish, to tan, to straw. Spots may occur in same place year after year, and will first reappear where disease was active the year before. Prevalent near sidewalks, buildings, and southern slopes.
- What do I do? Maintain 5.8-6.0 pH in root zone, raise mowing height in hot weather, avoid fluctuation in soil from wet to dry, try slow release fertilizers rather than soluble, core aerate to improve layering. Cool down areas routinely attacked by summer patch; damage is worst in soil 5-10° warmer than surrounding areas. Remove excess thatch.
- Will the grass die? Yes. The pathogen attacks the roots.
- Time your first preventative applications of biological control like Bacillus subtilis for around tax time. Once you see symptoms, the grass is already dead.

**Necrotic Ringspot**: A root pathogen very similar to summer patch, but tends to occur in new turf stands. Like summer patch, it occurs in the hottest part of the lawn, but you will tend to see it either prior to June or from mid-August on. Any treatment should still be in mid-April. Favored hosts are fescue and Kentucky bluegrass; it DOES NOT AFFECT RYE. This is also a disease made worse by manganese deficiency.

Most importantly, avoid over watering. It is tempting to irrigate lawns with a history of NRS more frequently, but this will enhance the disease. Water to 6-8” infrequently as possible, usually no more than twice a week, without creating water stress. Check irrigation heads are working properly, and limit overlapping sprays that may create puddles. **Prepare site before sodding or seeding.** Necrotic ring spot is more severe on sites with compacted soils and poor soil drainage.

**Necrotic Ringspot**
- Can I see it with the naked eye? Possibly, or only see swirly area of browned out grass.
- Is it obvious? Possibly, or it may be a diffuse thinning or browning.
- What grasses get it? Bluegrasses, bents, fine fescues.
- What kind of weather? Mild weather in fall and spring.
- What do I look at first? The entire turf stand, the roots.
- What do I see? Frog eyes (tan circles with apparently healthy grass growing in center), or sunken bronzed patches in lawns less than four years old. Roots discolored dark brown or black.
- What do I do? Overseed with resistant varieties, avoid serious fluctuations in soil moisture, use slow release fertilizers, avoid excessive watering, avoid compaction, top dress with compost.
- Will the grass die? Yes. The pathogen attacks the roots.
- Time your first preventative applications of biological control like Bacillus subtilis for around tax time. Once you see the symptoms, the grass is already dead.
Anthracnose: Anthracnose commonly occurs in conjunction with other diseases like summer patch, Rhizoctonia (brown patch) and Pythium blight. There is a strong association between summer patch and anthracnose. Anthracnose infected grass heats up quicker because turf is thinner, so this may also be the first place you see symptoms of summer patch.

Two types of Anthracnose:
- Foliar: Presents as black bristles on the leaf. Present at 61-90º, optimal is 81-91º.
- Black basal rot: Begins to really affect plants at around 59º.

The more foliar anthracnose present, the more crown rot anthracnose.

70% of a current season’s disease is from over-wintering disease to healthy grass once SOIL temperatures hit 65º. Look for bright yellow leaves surrounding central green leaf. PURPLISH areas are a warning to water and add nitrogen. Yellowish spots mean failing plants. Avoid abrasive practices and spoon feed with about 0.116lbs of actual nitrogen per week through season, and then catch up with the rest of the fertility through fall.

<table>
<thead>
<tr>
<th>Anthracnose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Can I see it with the naked eye? Yes, using a hand lens.</td>
</tr>
<tr>
<td>Is it obvious? Usually.</td>
</tr>
<tr>
<td>What grasses get it? Bluegrasses, bents.</td>
</tr>
<tr>
<td>What kind of weather? Warm temperatures, excessive moisture, stress.</td>
</tr>
<tr>
<td>What do I look at first? Leaves.</td>
</tr>
<tr>
<td>What do I see? Elongated reddish brown spots that eventually become small, black, hairy dots on dead and dying leaf tissue. May see yellow outer leaves, while still green center leaf detaches easily like a rotted tooth. Check for water soaked crowns. Common with excessive moisture, combining with factors that slow grass growth. More common on annual bluegrass, but also seen on bents. May see in conjunction with leafspots.</td>
</tr>
<tr>
<td>What do I do? Increase mowing height, decrease compaction, core aerate, no heavy N applications especially during drought or heat wave (spoon feed instead), reduce traffic.</td>
</tr>
<tr>
<td>Will the grass die? On a golf course during hot weather YES. Try to fix stress factors to improve chances for survival.</td>
</tr>
<tr>
<td>Symptoms will be worse during hot weather.</td>
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</tbody>
</table>

Rhizoctonia/Brown Patch: There are different species present at different times of the year, as different Rhizoctonia occur at different temperatures:
- 45-65º for R. cerealis
- 60-85º for R. solani
- 85-100º for R. zea, which attacks grass crowns and sheaths

As temperatures warm, brown patch may first infect ROOTS, then stolons, then leaves; but the MOST susceptible place for entry is the cut ends of the grass. Just like dollar spot, the mycelium can bridge plant to plant and uses nutrients in guttation fluid. Worm casts are a source of inoculum. Early AM hosing, poling, or dragging of turf reduces Rhizoctonia; results improved if before 7:00AM. Look for reddish winter color, the higher the percentage, the more likely to develop Rhizoctonia during the course of the following season. Look at emerging roots and new roots in these areas: they will become necrotic and die at 0.5-1” when correlated with Rhizoctonia. In rye, usually see this onset between 200-300 Growing Degree Days.
**Treatment for Rhizoctonia/ Brown Patch**
Compost supplemented with an organic N source like blood meal may reduce incidence of disease indirectly. When applied as a topdressing or topdressing mix amended with plant and animal meals, composted animal manures, plant debris, or composted turkey litter may also help. Use of urea may enhance brown patch. Do not irrigate in late afternoon or evening.

<table>
<thead>
<tr>
<th>Brown Patch (Rhizoctonia)</th>
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</thead>
<tbody>
<tr>
<td>Can I see it with the naked eye? Probably not. You may see irregular brown lesions, tip blighting or smoke rings on closely mowed turf.</td>
</tr>
<tr>
<td>Is it obvious? Sometimes.</td>
</tr>
<tr>
<td>What grasses get it? Bents, bluegrasses, rye, fescue, Zoysia.</td>
</tr>
<tr>
<td>What kind of weather? Cool wet or warm wet (75-95º AM, 70º PM)</td>
</tr>
<tr>
<td>What do I look at first? Leaves.</td>
</tr>
<tr>
<td>What do I see? Smoke rings on golf turf, or circular areas that appear a different color than surrounding areas. There may be blight or die back from leaf tips. May see brown patches with darker border, especially in AM. Kentucky bluegrass may appear to have reddish blades or whish spots with red margins (a bit like dollar spot). In warm weather, the size of the patch affected may increase rapidly over a day or two. Blighting of leaf tips may last 1-3 weeks.</td>
</tr>
<tr>
<td>What do I do? Improve drainage, reduce compaction, DO NOT over-fertilize, avoid excess soluble nitrogen, irrigate deeply and infrequently, DO NOT water every day, mow early in AM to speed leaf drying, remove excess thatch, use organic amendments like composted poultry litter, compost, or animal and plant meal.</td>
</tr>
<tr>
<td>Root health and turf density can be seriously affected.</td>
</tr>
</tbody>
</table>

**Monitoring Tip:** Activities or organisms that injure roots INCLUDING Rhizoctonia can be seen before the actual appearance of brown grass. Reduced root systems and attendant water stress cause this MAJOR CLUE: areas infected have NO guttation fluid or dew early in the morning while surrounding grass is covered. Infected areas also don't grow as quickly after mowing, meaning, they heat up quicker, and thus are areas first hit by anthracnose.

**Red Thread:** Most grass outgrows symptoms with weather change. Grass may take on an overall bleached appearance, but no real harm is done unless the disease persists steadily for 3-4 weeks. Composted poultry litter may help grass outgrow it. A more permanent solution is to overseed with endophytic fine fescues, which can reduce disease incidence dramatically.

<table>
<thead>
<tr>
<th>Red Thread</th>
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</thead>
<tbody>
<tr>
<td>Can I see it with the naked eye? Yes.</td>
</tr>
<tr>
<td>Is it obvious? Yes</td>
</tr>
<tr>
<td>What kinds of grass get it? Bents, bluegrass, fescues, rye.</td>
</tr>
<tr>
<td>What kind of weather? Cool, wet.</td>
</tr>
<tr>
<td>What do I look at first? Leaves.</td>
</tr>
<tr>
<td>What do I see? Red or pink strands near tips of leaves binding them together, or fuzzy pink on dead leaves. Infected leaves turn straw color.</td>
</tr>
<tr>
<td>What do I do? Fertilize properly, reduce compaction, irrigate, use organic amendments.</td>
</tr>
<tr>
<td>Will the grass die? Probably not.</td>
</tr>
</tbody>
</table>
**Rust:** Usually an indicator of weak, dry, or undernourished turf and, like red thread, comes and goes with weather. Rust is mostly seen from about mid-October until frost, often during “Indian Summer.” The incorporation of compost as a top dressing or in new turf plots may reduce rust by providing a bit of moisture retention, and nutrition can make a big difference in the level and persistence of the disease.

<table>
<thead>
<tr>
<th>Rust</th>
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</thead>
<tbody>
<tr>
<td>➢ Can I see it with the naked eye? Yes!!</td>
</tr>
<tr>
<td>➢ Is it obvious? Yes!!</td>
</tr>
<tr>
<td>➢ What kinds of grass get it? Bluegrasses, rye, Zoysia (Can be serious.)</td>
</tr>
<tr>
<td>➢ What kind of weather? Cool, wet weather, moisture for 10-12 hours, fog.</td>
</tr>
<tr>
<td>➢ What do I look at first? Leaves.</td>
</tr>
<tr>
<td>➢ What do I see? Yellow, orange, or red lesions surrounded by green, yellow, brown borders depending on age and susceptibility of grass; severely affected grass has red or yellow cast, may be huge clouds of spores which turn shoes and clothing orange.</td>
</tr>
<tr>
<td>➢ What do I do? Mow frequently, avoid prolonged drying, irrigate, reduce compaction, increase light and air circulation.</td>
</tr>
<tr>
<td>➢ Will the grass die? No.</td>
</tr>
</tbody>
</table>

**Leaf Spot:** A symptom of stress, often attacks plants in shade or receiving improper irrigation.

<table>
<thead>
<tr>
<th>Leaf Spot (excluding gray leaf spot)</th>
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</thead>
<tbody>
<tr>
<td>➢ Can I see it with the naked eye? Yes!</td>
</tr>
<tr>
<td>➢ Is it obvious? Yes!</td>
</tr>
<tr>
<td>➢ What kinds of grass get it? Bents, bluegrasses, rye, fine fescues, rye, Zoysia.</td>
</tr>
<tr>
<td>➢ What kind of weather? Cool wet weather for spots; hot wet weather for major damage.</td>
</tr>
<tr>
<td>➢ What do I look at first? Leaves.</td>
</tr>
<tr>
<td>➢ What do I see? Browning. Thinning. Circular to elongated purple with brown, red, white tan, straw centers. Leaf blotch, tiny red or purple spots on blades and sheaths. Seedlings are most susceptible and often die. Zoysia dies back from tip during hot, wet weather. Look for first signs of leaf spot on bluegrass; may look like dull mower injury on bents. You may see tip blighting or a reddish brown to black crown root rot, and few, shallow, or lacking feeder roots. Older leaves are more susceptible than young. In warm weather, leaf spot is restricted to roots and crowns. Kentucky bluegrass is susceptible when sugar is low, i.e., overcast weather, or succulent growth.</td>
</tr>
<tr>
<td>➢ What do I do? Avoid planting grass in shade; leaf spot appears first on shaded grass. Mow high, leaf sport is worst on closely mowed turf. Reduce thatch, don’t over fertilize, improve drainage, try not to mow or irrigate when disease is active, irrigate deeply and infrequently, apply higher rates of nitrogen in fall than spring. For fine fescue, don’t over irrigate or keep wet; avoid all light frequent irrigation. Avoid soluble fertilizers like urea or ammonium nitrate. DON’T sprinkle in early evening; the more often the grass is wet or remains wet, the greater chance of establishment, and once there, it’s always a problem. Avoid use of plant growth regulators. Increase air circulation.</td>
</tr>
<tr>
<td>➢ Will the grass die? Leaf spot will attack roots and crowns. In hot windy weather, yes; this is known as melting out. Discrete spots seen in spring and fall will not kill the plants.</td>
</tr>
<tr>
<td>➢ Most varieties of grass are now somewhat leaf spot resistant. If you do use a fungicide, only contact fungicides are useful against leaf spots.</td>
</tr>
</tbody>
</table>
MUSHROOMS IN THE LAWN
Often arise from remnants of old roots in soil. May be more prevalent after several days of light sprinkling.

**Fairy Ring**
- Can I see it with the naked eye? Yes.
- Is it obvious? Yes.
- What kinds of grass get it? Most.
- What kind of weather? Infection occurs all year during periods of high humidity.
- What do I look at first? Fairy rings are actually fronts of fungus infesting the soil. Take a sample of soil; break it apart to see if it smells moldy.
- What do I see? Look for a strange green arc or ring, or an arc/ring of mushrooms, or if it is really bad, death of turf in a circular pattern.
- What do I do? Use a wetting agent to try to ensure soil does not become hydrophobic.
- Will the grass die? Usually not.
- Should I use a fungicide? No. Fungicides are ineffective against fairy ring. The fairy ring usually resolves itself. You can try using a little nitrogen to mask the darker color.

VOLES
Voles, also known as meadow mice, have plump bodies, short hairy tails, and small eyes and ears in proportion to the head. Fully grown, they are about 7” long and have rather coarse hair. They eat a variety of grasses, broad-leaf weeds (every pest has a plus), seeds, tubers, bulbs and rhizomes. They also eat tree bark including that on roots. They do not hibernate and remain active all year, mostly during the day. They can produce a new generation in about 60 days. Like moles, their population fluctuates from year to year. Fortunately, many are consumed by natural predators, and the mortality rate of the young is more than 80% prior to reaching one month. The lifespan of the vole is short, from 2-16 months.

- **Moles** have greatly enlarged front feet with prominent claws for digging.
- **Shrews** have long, pointed snouts and needlelike front teeth.
- **Voles** have blunt snouts with chisel-like front teeth.

There are two prevalent types of vole:
The **meadow vole** usually has a run at the surface in ground cover and a long tail.
The **pine vole** is tougher to control, has a shorter tail, and tends to damage plant root systems and even to girdle plants.

These are both incidental to turf problems; they may use the abandoned tunnels of moles for transport. On ornamentals they area serious problem. Look for tiny 1-2mm wide tooth marks and scratch marks where bark is removed. Reducing grounds covers helps to reduce meadow vole populations; weed fabric is especially favored by voles because they can travel along beneath it. Switch to mulch that will not hold its shape during vole tunneling, such as large bark chunks. Finely shredded mulch, which tends to pack, is perfect for them to create a tunnel in.

Voles can be caught with live capture traps or any kind of mouse trap, with an overhead tent of roofing shingles, or an upturned 5 gallon bucket. Use a bait of 1 slice of apple under a shingle to survey. If 5% of the slice is missing for areas around immature trees and shrubs, control them. If 10% is missing for mature trees and shrubs, control them.
MOLES
There are two kinds of mole: Star-nosed and Eastern.

They are not rodents; they are in the same group of mammals as shrews. Moles are considered beneficial for their insect eating and aeration abilities. Moles eat more than grubs and are primarily carnivorous so they do not damage plants by feeding.

Once the moles have moved on, you can expect your grass to thrive better than before, thanks to the effect of tunneling aeration.

Moles are mostly nocturnal, and do not resemble mice at all.
- The head and body range from 4.3 to 6.7” in length.
- They have thick fur that ranges in color from silver to black to copper.
- The short round tail ranges from ¾-1½” in length and is almost hairless.
- There are no external eyes or ears.
- They have very poor eyesight, and can only see light vs. dark.
- Their large, almost hairless front feet have webbing between the toes.
- They are powerful diggers, having been clocked at a rate of 14.8ft per hour, or 101.8ft per day!!
- Their major food source is earthworms.
- Their tunnels are on two levels, with upper tunnels used for transportation, lower for living space.
- Moles are known to seek well-irrigated lawns during dry spells just for the moisture.
- Moles are mostly solitary, mating in spring.
- They are very territorial; two moles at the most are doing all the tunneling in an average location.
- Mole populations are not constant. Extra rain will cause a temporary increase in numbers, and possibly in activity since it will also cause grubs to stay near the surface.

Eastern moles prefer well-drained, loose soil in lawns and gardens. They are not found in rocky soil or clay.

Star-nosed moles prefer wet areas in woods, fields, or swamps. Presence of star nosed moles indicates you may be over irrigating.

Moles get a bad name for damaging turf which, when disturbed by tunneling, may shrivel up and die during hot weather. If you are disturbed by the presence of mole tunnels, you can roll the area lightly and water the area. The mounds shouldn't interfere with mowing unless you have your mower blade set too low, which isn't good for the grass anyway. If you have multiple tunnels, even them off with a shovel and top dress with the excess.

Harpoon traps set under a five-gallon pail are effective, or you can try castor oil deterrent products available commercially. Irrigation or rain will leach the repellent decreasing its effectiveness. Otherwise, the application can remain effective for 30-60 days. To find best places to trap, stomp the tunnels, and then look for which are reactivated in the next 24-48 hours.
PART TWO: Soil Testing

HOW TO SOIL SAMPLE
- When: Early enough to get soil test results back.
- How: 2-3” depth for turf, 4-6” other plantings.
- Where: Take multiple samples at same depth removing any large objects, mix in plastic container for composite sample.
- Sample separately each area with different liming or fertility practices.
- Each area to be sampled should be represented by 10-15 soil core sub-samples.
- Homogenize sub-samples in plastic container. (Do not use metal.)
- Submit 2/3 pint of composite sample from each separate area with different liming or fertility practices.

Caveats for Soil Sampling
- Except for deeply rooted trees and shrubs, use only the surface horizon for soil testing. Otherwise, your results may not reflect the true nature of the zone where root growth occurs and where you are interested in making changes or marking values.
- Seasonal variation: phosphorous and potassium may be lower in spring and late summer.
- The pH of coarse textured soils is often reduced by 0.5 pH (a lot in a log scale) by recent addition of acidifying fertilizer.
- Microbial activity, growth of plant roots, and increases in soil temperature can also result in a REDUCTION in soil pH.
- For frequently tilled areas sample to a depth of 6-9”, for lawns to a depth of 2-3”, for trees and fruits use two samples: one from 0-8” and another from 8-24”.
- Do not sample when extremely wet or when soil is frozen.

Why Soil Tests Disagree: When we send tests out to separate labs, (a local option for soil tests is the Cornell Cooperative Exchange Horticultural Diagnostic Lab,) we get reports that are completely different. This is influenced by several factors:
- The kind of test performed
- A difference in type of units reported (these can be converted)
- The type of plant indicated as the crop for that location.
- Or in the case of phosphorous, the type of soil tested.

Lime recommendations will be different depending on if the lab has figured in buffering capacity, and depending on soil type. pH tests can also differ based on method used. If something seems off, ask questions.

What is Included in a Typical Soil Test?
- Soil pH
- Lime requirements as a function of buffering capacity
- Soluble salts
- Levels of Phosphorous (P), Potassium (K), Calcium (Ca), Magnesium (Mg), Manganese (Mn), Iron (Fe), and Zinc (Zn)

WHAT IS PH? pH is a measure of the soil’s acidity. The lower the pH, the more acid the soil. When pH is low, lime is added to increase or “sweeten” the soil. The pH scale is a logarithm, so a pH of 5 is ten times more acid than a pH of 6, 100 times more acid than a pH of 7, etc.
**How Does pH Affect Fertility and Fertilizer Availability?**

- If pH is 4.5, about 75% of applied fertilizer may be unavailable to plants
- If pH is 5, about 54% of applied fertilizer may be unavailable to plants
- If pH is 5.5, about 33% of applied fertilizer may be unavailable to plants
- If pH is 6.0, about 20% of applied fertilizer may be unavailable to plants
- If pH is 7.0, about 0% of applied fertilizer should be unavailable to plants

pH is like the bank teller that tells your plants if they can make a nutrient withdrawal, since plants cannot access certain nutrients when the pH is too high or too low. Most plants prefer a pH between 6 and 7 with optimal a 6.5. Turf does best with a pH between 6 and 7.

**Lime Recommendations:** Lime incorporated pre-plant should be done to a depth of at least 6”. Lime applications should never exceed 50lbs/1000sqft in a single application. Often you will have to split a greater amount recommended into 2 or even 3 apps, by season. If applying to established plantings without incorporating, never apply more than 50lbs/1000sqft/application.

**Soil Buffering Capacity in Relation to pH**
The buffering capacity of the soil is its ability to withstand rapid pH fluctuation. The greater the buffering capacity of the soil, the greater quantity of acid or base that must be incorporated into the soil to alter its pH.

- Soil types with LOW buffering are sandy soils with little clay or organic matter.
- Soil types with HIGH buffering are those with greater amounts of clay or organic matter; these will need more lime or acidifying product to effectively change pH.

**When do Lime Recs take into account Buffering Capacity of Soil?**
Some soil tests refer to the lime index which = buffer pH; the value is reported without a decimal point to distinguish it from the regular soil pH. The lime recommendation is then based on a calculation of the difference between the soil pH and the lime index. A higher lime index indicates soil is more susceptible to changes in pH.

**PRE-PLANT LIMING RATE: LBS LIME/1000 SQFT (TO RAISE pH TO 6.5)**

<table>
<thead>
<tr>
<th>PH</th>
<th>SAND</th>
<th>LOAM</th>
<th>CLAY</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.0</td>
<td>300</td>
<td>125</td>
<td>165</td>
</tr>
<tr>
<td>4.5</td>
<td>100</td>
<td>125</td>
<td>235</td>
</tr>
<tr>
<td>5.0</td>
<td>75</td>
<td>85</td>
<td>175</td>
</tr>
<tr>
<td>5.5</td>
<td>50</td>
<td>50</td>
<td>110</td>
</tr>
<tr>
<td>6.0</td>
<td>25</td>
<td>21</td>
<td>60</td>
</tr>
</tbody>
</table>

Application amount is dependent on soil texture. Always base lime applications on soil tests.

**How long does it take Lime to become Chemically Active in Soil once Applied?**
3-6 months. Do a pH test about 6 months pre planting so lime amendments have time to work.
What is the Difference between Calcitic and Dolomitic Limestone?
CALCITIC Limestone has less than 5% magnesium.
DOLOMITIC Limestone has more than 5% magnesium. (Pure magnesium carbonate is known as dolomite.)

What kinds of Liming Materials may I choose from?
- Pulverized: Fine, dusty, fairly fast acting.
- Granular: Slow acting, inexpensive.
- Pelletized: Fast acting, easy to spread, more expensive.

WAYS TO JUDGE HOW GOOD YOUR LIME IS
Effective neutralizing value - All lime is not created equal
- Look on label for the ENV. (Effective Neutralizing Value.)
- Divide 100 by this number.

The result is the amount of lime needed to provide one unit of 100% effective neutralizing value, which gives you true measure of cost to get the right amount to reach desired pH.

This can save you money!

For example:
Lime #1 has an ENV of 70. 100 divided by 70 =1.42. So for every pound of lime they recommend you put down, you actually have to put down 1.42 pounds!

Lime #2 has an ENV of 89.7. 100 divided by 89.7 =1.11. Even though Lime #1 is cheaper by the pound, it will cost more to treat your property because you ultimately have to buy more!

Calcium Carbon Equivalent (CCE): Another way to Judge Lime Value
Recommended liming rate/calcium carbon equivalent X 100 =actual amount of liming material to apply

TIP: Do not sabotage your liming efforts with acidic fertilizers.

What to do about High pH
- Sulfur (S) will be recommended if pH EXCEEDS 7.5.
- Depending on plant sensitivity, never apply more than 1-5lbs S/1000sqft/app.
- Apply S to turf ONLY in spring and fall.
- You can also use iron sulfate at 8.7lbs/1000sqft to acidify a high pH.
- Sample soil frequently at 1-2” and at 2-6” to make sure you are not acidifying just a shallow surface zone.
- Most of us are working with soils that tend to be acid. (Too low.)
- If your soil's pH tends to be TOO HIGH (alkaline), one solution is to add elemental S to acidify (lower) the pH.
- If you have a lot of free carbonates in soil, it is practically impossible to use S in this manner. Try this test: Take a soil sample, dry down a bit, add vinegar. If you get foaming, carbonates are present and it will be difficult to reduce soil pH using sulfurs.
To Reduce Soil pH add the following lbs of Elemental Sulfur/1000sqft

<table>
<thead>
<tr>
<th>Existing pH</th>
<th>Desired pH</th>
<th>Sandy Loam</th>
<th>Loamy</th>
<th>Clay</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>7.0</td>
<td>4.0</td>
<td>8</td>
<td>11</td>
</tr>
<tr>
<td></td>
<td>6.5</td>
<td>5.7</td>
<td>11.3</td>
<td>15.7</td>
</tr>
<tr>
<td>7.5</td>
<td>7</td>
<td>1.7</td>
<td>3.3</td>
<td>4.7</td>
</tr>
<tr>
<td></td>
<td>6.5</td>
<td>3.3</td>
<td>6.7</td>
<td>9</td>
</tr>
<tr>
<td>7</td>
<td>6.5</td>
<td>1.7</td>
<td>3.3</td>
<td>4.7</td>
</tr>
</tbody>
</table>

**MACRONUTRIENTS**

**TIP:** Nitrogen is constantly changing in soils, so soil tests for nitrogen are of very limited value for predicting nitrogen needs. On many soil tests, no tested values for nitrogen appear.

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Low lbs/acre</th>
<th>Medium lbs/acre</th>
<th>High lbs/acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phosphorous</td>
<td>0-3</td>
<td>4-8</td>
<td>Greater than 9</td>
</tr>
<tr>
<td>Potassium</td>
<td>0-150</td>
<td>150-300</td>
<td>Greater than 300</td>
</tr>
<tr>
<td>Magnesium</td>
<td>Less than 65</td>
<td>66-100</td>
<td>Greater than 100-199</td>
</tr>
<tr>
<td>Calcium</td>
<td>Less than 3,500</td>
<td>3,500-5,200</td>
<td>Greater than 5,200</td>
</tr>
</tbody>
</table>

**Why would I have a Soil Test with High Calcium Levels?**

Extractable levels increase with clay content. The Ca levels of poorly drained, loamy sand, or sandy soils are likely to be higher because a clay type soil or one with more organic matter has more charge to hang onto the Ca. Or you may have concrete leaching or street sweepings as a component of manufactured soils.

**MICRONUTRIENTS**

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Normal range in lbs/acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manganese</td>
<td>60-80</td>
</tr>
<tr>
<td>Iron</td>
<td>20-50</td>
</tr>
<tr>
<td>Zinc</td>
<td>0-1</td>
</tr>
<tr>
<td>Aluminum</td>
<td>20-80</td>
</tr>
</tbody>
</table>
WHAT IS A CATION?
A cation is an ion with a positive charge that will stick to things with a negative charge, such as water, clay particles, and organic matter.

The collective ability of a soil to hold on to cation nutrients is called cation exchange capacity (CEC).

What is Cation Exchange Capacity (CEC)?
Clay and organic matter have negative charges, so CEC capacity is a measure of a soil as water, to hold exchangeable cations like Ca ++, Mg++, K++, Cu++, Mn++, Zn++, and Fe++. The higher the CEC, the larger the fertilizer application of cations has to be in order to fill up all the binding sites.

Soils with lower CEC need smaller, more frequent fertilizer applications to keep binding sites filled. Nutrients with negative charges are repelled by cation exchange complexes so therefore easily leach with excess water, which has both a positive and negative charge on its molecules. These include nitrate NO3-, chloride (cl-)2, sulfate (so4-2) and borate (Bo3-3).

Thus even moderate amounts of organic matter provide a great deal of CEC.

Typical CEC Ranges

<table>
<thead>
<tr>
<th>Soil Texture</th>
<th>Common CEC Ranges</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sand to sandy loam</td>
<td>0-12</td>
</tr>
<tr>
<td>Sandy loam to silty clay loam</td>
<td>8-30</td>
</tr>
<tr>
<td>Silty clay loam to clay</td>
<td>20-40</td>
</tr>
</tbody>
</table>

Sometimes amount of nutrients will be listed as a function of what is held on the CEC complex. Below are acceptable ranges:

<table>
<thead>
<tr>
<th>Available P</th>
<th>1.5-2.3lbs/1000sqft</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exchangeable K</td>
<td>7-11.5lbs/1000sqft</td>
</tr>
<tr>
<td>Exchangeable Ca</td>
<td>46-138lbs/1000sqft</td>
</tr>
<tr>
<td>Exchangeable Mg</td>
<td>5.8-23lbs/1000sqft</td>
</tr>
</tbody>
</table>
What is Base Saturation in relationship to Cations?
While there are many negatively charged sites for positively charged cations to bind with in soil, they are not all filled all the time. There is an optimal range for percentages of sites to be filled:

- Ca++ 50-70%
- Mg++ 8-20%
- K+ 1-9%
- Na less than 4%

If you get readings lower than this, you may end up with a somewhat higher application recommendation. Readings may not correlate well with nutrient content in plant tissues, or growth in the field.

WHAT IS EXCHANGE ACIDITY?
Sometimes your soil report will have “exchange acidity” on it if your pH is below 6. This is a measure of the number of H+ ions stuck to soil that can be replaced by Ca++ or Mg++ on cation exchange sites to help neutralize soil acidity and will be given in milliequivalents per 100 grams of soil (ME/100g).

SOLUBLE SALTS
Cornell soil tests for soluble salts and reports values in mmho/cm:

- 0-25 mmho/cm is low: do nothing.
- 25-75 mmho/cm is medium: still to do nothing.
- 75-100 mmho/cm is HIGH: recommendation is heavy watering and fertilizers with low salt index. (Listed on bag, the closer the value is to 100, the greater the salts hazard.)
- +100 mmho/cm is EXCESSIVE: recommendation is heavy watering, and to use salt tolerant species.

What About Using Gypsum when Soluble Salts are High?
In the case of a saltwater overwash such as we had in Hurricane Sandy, leach with 1” of water every other day for 20 days. Or, in combination with this leaching regimen ONLY, apply gypsum at a rate of 46-138lbs/1000sqft, with more positive effect seen on less sandy soils.

Gypsum Test for Potential Soil Benefit

- Take two, 4oz soil samples from affected site using a soil corer, dry and crush until largest particles are sesame seed sized.
- Mix generous ½ tsp of gypsum (we would standardize this in grams using a digital scale) with sample of crushed soil.
- Take a second sample of crushed soil without added gypsum.
- Prepare two empty cans with both metal ends removed.
- Cover one open end of each can with fine screening (e.g., window screen) so water may drain but soil cannot fall through.
- Place each soil sample in a can; each can should be about 3/4 full.
- Tap cans approximately ten times on a hard surface to settle soil.
- Place cans over separate collection containers and fill to brim with water carefully so as not to disturb soil.
- Add the same amount of water to each can.
- Compare the amount of water collected when cans finish draining
- If less than half as much water has passed through the soil that was not mixed with gypsum, the addition of gypsum may help to improve drainage in the location from which the soil was obtained.
PART THREE: Understanding Soils

THE MEANING OF SOIL COLOR
- Dark soil is associated with organic matter.
- Brown-red soil is associated with adequate air and good drainage.
- Yellow soil is associated with imperfect drainage.
- Mottling/streaking of the soil is associated with seasonal periodic water problems.
- Mottled blue green / gray soil is associated with poor drainage. Dig into the soil for a depth of 12-15” to find underlying drainage issues. You will usually encounter foul odor and/or reddish streaks of chemical change known as “gley.”

WHEN SHOULD YOU HAVE PHYSICAL TESTS OF SOIL DONE?
- On new construction sites.
- During construction projects to insure quality control of new soil loads.
- To check for contamination of old soil loads.

Cover soil loads to prevent contamination from material blown in or arriving in runoff. For soil that is already on site, take undisturbed samples from problem areas and evaluate physical condition.

COMMON SOIL PHYSICAL TESTS
- Particle size analysis: percent sand silt and clay, DEFINING soil types, textures
- Bulk density
- Saturated hydraulic conductivity = infiltration rate
- Porosity/water retention: occupation of air after free drainage vs. occupation of water after free drainage

Determine your Soil Type: Texture by Ribbon Test
1. Place 2tsp of the soil in your palm and drip water onto it, kneading until it forms a ball.
2. Does the soil remain in a ball when squeezed? If not, you have mostly sand.
3. If the ball forms, squeeze it between your thumb and forefinger into a ribbon of sorts.
   - Loam: Weak ribbon less than 1” before breaking.
   - Silty Loam: Ribbon holds together and appears to be “ruffled” or has cracks in it.
   - Clay Loam: Medium ribbon 1-2” before breaking.
   - Clay: Strong ribbon 2”+ before breaking, may explain drainage problems.

Determine Soil Type, Texture by Jar Test (rough estimate)
Fill half a jar with soil; add water until full, shake one minute, let settle:
- Gravel and sand settle to bottom
- Clay and silt are next layer
- Dark layer on top = organic matter

Specifications for soil texture
Soil particle size is the mineral fraction of the soil divided into sand silt and clay. The way they hang together is called an aggregate. Sizes for various particles:
- Gravel: greater than 2mm
- Very coarse sand: 2-1mm
- Coarse sand: 1-0.5mm
- Medium sand: 0.5-0.25mm
- Fine sand: 0.25-0.1mm
- Very fine sand: 0.1-0.05 mm
- Silt: 0.05-0.002 mm
- Clay: less than 0.002 mm
FORMAL SAND DEFINITIONS
Sand does not have to be 100% sand; in fact it is any soil material at least 85% sand.

- Taken backwards, a sand is any soil material where the percentage of silt + 1.5 times the percentage of clay does not exceed 15. 85+15=100.
- The official abbreviation is Sa.
- Squeeze sand dry and it falls apart. Squeeze it wet, it forms a ball but immediately falls apart when disturbed in any way.
- Sand is defined as 25% or more very coarse + coarse + medium (0.5-0.25mm) sand and less than 50% fine sand (0.25-0.1mm) or very fine sand (0.1-0.05mm).

Coarse sand is 1-0.5mm in size, and is defined as 25% or more very coarse/coarse sand, and less than 50% of any other single grade of sand.

Very coarse sand is 1-2 mm in size.

Fine sand is defined as 50% or more of fine sand OR less than 50% very fine sand.

Very fine sand is 50% or more of very fine sand.

Sand by definition will form a cast when wet, crumbles easily and, this is very important, 100% will pass through a 2mm sieve, because the largest particle, very coarse sand, is 1-2mm. It does NOT make a ribbon.

Loamy sand has two limits, an upper and a lower:
- Upper limit loamy sand has 85-90% sand. The percentage of silt + 1.5 times the percentage of clay will never be less than 15.
- Lower limit loamy sand will not contain less than 70-85% sand and the percentage of silt + twice the percentage of clay will NOT exceed 30.

The official abbreviation is Lsa. Loamy sand is 25% or more very coarse, coarse, and medium sand + less than 50% of any other single grade of sand. By definition, loamy sand will NOT form a ribbon, will form a cast when wet, and sand grain can be felt when rubbed between your fingers.

Loamy coarse sand is 25% or more very coarse and coarse sand + less than 50% of any other single grade of sand.

Loamy fine sand is 50% or more of fine sand OR less than 25% very coarse, coarse, and medium sand + less than 50% very fine sand.

Loamy very fine sand is 50% or more very fine sand.

Why sand shape is important: Sands that are very spherical may be unstable. Sands that are flat and angular may pack excessively, even though the size distribution is favorable.
**TIP**: Uniformity Coefficient (Cu)
Very few labs report this, but it is very important: the acceptable range is 2-4; optimum range is 2-3. The higher the value, the less uniform the sand or soil mix, the GREATER THE POTENTIAL FOR PACKING, which can mean compaction troubles.

Sands with Cu less than 1 may not pack at all, resulting in unstable surfaces during grow in and beyond.

**What is the difference between Sandy Loam and Loamy Sand?**
Sandy loam is a soil material that contains 20% or less of clay, the percent of silt + two times the percent of clay exceeds 30, AND has 52% or more of sand.

A second definition of sandy loam is a soil material of less than 7% clay, less than 50% silt and a sand range of 43-52%. The official abbreviation is SaL.

**Coarse sandy loam** has 25% or more very coarse and coarse sand + less than 50% of any one other grade of sand.

**True sandy loam** has 30% or more of very coarse, coarse and medium sand, BUT less than 25% very coarse sand and less than 30% fine sand or very fine sand.

**Fine sandy loam** has 30% or more fine sand and less than 30% very fine sand OR 15-30% very coarse, coarse, and medium sand.

**Very fine sandy loam** is 30% or more very fine OR greater than 40% fine and very fine sand, at least half of which is very fine sand AND less than 15% very coarse, coarse, and medium sand.

**TIP**: Uniformity of a sand will influence physical properties of a sand-based mix:
- Sands that fall into two ADJACENT size categories and are uniform or uniformly graded, will have good compaction resistance and maintain a fairly uniform pore size between sand grains.
- If you have sand with particles falling across several size fractions, these are lacking uniformity (widely graded) and tend to pack tightly, producing small pores between sand grains.

**TIP**: Uniformity of sand affects bulk density.
Low uniformity = tight packing = higher bulk density = greater compaction potential

**TIP**: By definition, sandy loam less than 10% clay will be slightly plastic. Sand grains can be seen and felt between the fingers when rubbed together after being lightly dampened, and will feel gritty. The ribbon test length is 0-0.75”. A sandy loam that is 10-20% clay feels similar, only more plastic, but the ribbon formed is three quarters to an inch and a half. Sandy loam, if squeezed when moist, forms a ball that will not break when dropped into an open hand.
**Loam**
This is the Cadillac of soils, a material that contains 7-27% clay, 28-50% silt and less than 52% sand. By definition loam is somewhat gritty, but less so than sandy loam and forms a ribbon that is a quarter to one and a half inches long. The official abbreviation is L.

**Silt loam** has 50% or more silt and 12-27% clay OR 50-80% silt and less than 12% clay. It will feel smooth, slippery, and velvety between your fingers. The official abbreviation is SiL.
- When silt loam is dry, it feels soft and floury, and forms clods easily pulverized. The 0-1.5” ribbon will have ruffles or cracks readily apparent.
- When wet, it has a smooth doughy feel.
- When moist it can form long ribbons that can be freely handled without breaking. When moist and smeared firmly between thumb and finger, it will have a broken appearance rather than a shiny rubbed surface.

**Silt** all by its lonesome is defined as soil material with 80% or more silt and less than 12% clay.

**Sandy clay loam** is soil material with 20-35% clay, less than 28% silt, and 45% or more sand. It is somewhat gritty and although quite resistant to ribboning, can actually form a ribbon of 1.5-2.5” length. The official abbreviation is SaCL.

**Clay loam** has a 27-40% clay to 20-45% sand ratio. It is moderately resistant to forming a ribbon, but in the end also makes 1.5-2.5” ribbon that is smooth and shiny. The official abbreviation is CL.

**Silty clay loam soil** has 27-40% clay but a sand content of less than 20%. Although slippery, this soil is dull, and will ribbon more easily into a long, thin ribbon of 1.5-2.5” that is both plastic and gritty. The official abbreviation is SiCL.

**Clay**
Is not pure clay, but is a soil material that contains 40% or more clay, less than 45% sand and less than 40% silt. It can make a ribbon exceeding 2.5” that is smooth and shiny. The ribbon will be long and thin, perhaps even threadlike. The official abbreviation for clay is C. It forms hard lumps or clods when dry, and is plastic and sticky when wet. Pinch it, and forms a long, thin, flexible ribbon that does not break easily.

**TIP:** Soils that have 25% clay or less are good for plant growth.

**Gravel**
Will pass a .75mm sieve but be retained on a 2mm sieve. All soil types when mixed with greater than 15% gravel can be designated as:
- Gravelly (15-35% gravel)
- Very gravelly (35-60%)

This designation is usually expressed before the soil texture name, e.g., gravelly clay loam.
**IMPORTANT FACTS ABOUT SOIL TEXTURE**

Texture changes for every topsoil source, and for every few inches deeper you go into the soil.

Use other senses besides touch. For instance, observe bare ground after a rain to see how much sand or silt washes out.

Clayey soils have sand-sized granules of soil and make a thin or cloddy crust that cracks apart quickly after rains.

**TIP**: Always estimate rock volume of a soil prior to purchase.

To estimate % volume of gravel or small rocks, use a 1lb coffee can, or a 3lb can for soils with cobbles or bigger rocks.

- Fill can to top, packing soil in as you fill.
- Pour soil out onto a tarp; clean most of dirt off rocks. (Bigger than 1/8” is a rock.)
- Discard rocks and pour soil back into can, packing as before.
- Measure down to top of packed soil. Volume of rocks is amount of air space left at top of can.

For example:

Can is 5.5” tall but measurement to top of soil is 2.5” after rocks are discarded.

Rock volume then = 2.5/5.5 or 45%.

Do you really want to pay for this?

**SOIL AGGREGATION**

Soil structure = arrangement of texture particles into aggregates.

How do we know if these aggregates are stable?

- **Good stability**: Small, friable, “sugary” aggregates, no significant clodding, many tiny spaces (macropores) between and within aggregates, lots of roots.
- **Moderate stability**: Significant quantities of the above type of aggregates, with significant coarse, firm clods, significant reduction of soil macropores, and moderate numbers of roots.
- **Poor stability**: Dominant is coarse, firm to very firm clods, with far fewer small sugary aggregates, no soil macropores visually apparent, few roots.

Poor aggregation: A very dense, hard soil which would show fragile, twisted roots at only a depth of 1.5-2”, clod-like soil structure with few vertical pores, and roots in a dense “mat” only an inch or two deep, as though grown on a glass plate.
**TIP:** Aggregate formation is dependent on freezing, thawing, wetting drying, root growth and soil organism activity to push particles together; these must be stabilized in some way. Under ideal conditions, aggregates are cemented in place by fungal byproducts, and decomposed organic matter which acts as “support pantyhose” to keep structure stabilized.

**TIP:** SOIL STRENGTH does NOT equal AGGREGATE STRENGTH. Soil strength is a measure of resistance to penetration. Compacted soils are defined as having greater resistance to penetration and higher bulk density.

**Aggregate Stability Test**
- Pass air-dried soils through a 2mm mesh and retain on 1mm mesh.
- Place sieved soil in small, open container with fine screen at bottom.
- Place container in distilled water for 5 minutes.
- Raise basket out of water and lower to bottom 5 times for about 1 second each time.

Stability is as follows:

<table>
<thead>
<tr>
<th>Stability Class</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Soil falls through sieve, too unstable to sample</td>
</tr>
<tr>
<td>1</td>
<td>50% of structural integrity lost within 5 seconds of insertion into water</td>
</tr>
<tr>
<td>2</td>
<td>50% of structural integrity lost within 5-30 seconds of insertion into water</td>
</tr>
<tr>
<td>3</td>
<td>50% of structural integrity lost within 30-300 seconds after insertion or less than 10% of soil remains on sieve after five dipping cycles</td>
</tr>
<tr>
<td>4</td>
<td>10-25% of soil remaining on sieve after five dipping cycles</td>
</tr>
<tr>
<td>5</td>
<td>25-75% of soil remaining on sieve after 5 dipping cycles</td>
</tr>
<tr>
<td>6</td>
<td>75-100% of soil remaining on sieve after 5 dipping cycles</td>
</tr>
</tbody>
</table>

**BULK DENSITY: WHY IS IT IMPORTANT?**
Bulk Density is used as a measure of soil wetness, volumetric water content, and porosity. Factors that influence the measurement include: organic matter content, porosity of soil, and soil structure. These factors in turn control hydraulic conductivity.
**Bulk Density (p) = Mass of oven dried soil / Total volume**

The bulk density of the soil can provide indication of the porosity and structure of the soil, which will govern O2 and H2O movement in the soil. It is also a measurement of the degree of compaction of the soil. If the soil has a high bulk density (compaction), grass seed will be restricted in emergence and root growth, which will affect total plant growth and yield.

**TIP**: Type of equipment tires will directly affect soil’s bulk density causing extreme compaction, especially if soil is wet.

**Minimum Bulk Density (in grams/cc) at which Root Restriction will Occur:**
- Coarse, medium, and fine sand, and loamy sands other than loamy very fine sand = 1.8
- Very fine sand and loamy very fine sand = 1.77
- Sandy loams = 1.75
- Loam and sandy clay loam = 1.7
- Clay loam = 1.65
- Sandy clay = 1.6
- Silt and silt loam = 1.55
- Silty clay loam = 1.5
- Silty clay = 1.45
- Clay = 1.4

**Ideal Bulk Densities**

<table>
<thead>
<tr>
<th>Soil Textures</th>
<th>Ideal Bulk Densities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sands, loamy sands</td>
<td>Less than 1.6 g/cc</td>
</tr>
<tr>
<td>Sandy loams, loams</td>
<td>Less than 1.4 g/cc</td>
</tr>
<tr>
<td>Sandy clay loams, loams, clay loams</td>
<td>Less than 1.4 g/cc</td>
</tr>
<tr>
<td>Silt, silt loams</td>
<td>Less than 1.3 g/cc</td>
</tr>
<tr>
<td>Sandy clays, silty clays, partial clay (35-45% clay) loams</td>
<td>Less than 1.1 g/cc</td>
</tr>
<tr>
<td>Clays (greater than 45% clay)</td>
<td>Less than 1.1 g/cc</td>
</tr>
</tbody>
</table>
INFILTRATION RATE
The ability of a root zone mix to conduct water under saturated conditions. Infiltration rate is reported in inches/hour, and may also be called: saturated hydraulic conductivity, ksat, or percolation (perc) rate.

GRAVITATIONAL WATER
Water that moves through the root zone under saturated conditions is called gravitational water; gravity is the driving force. After the water drains through a percentage of the pores, these pores will then be filled with air. This is called aeration porosity.

Aeration Porosity is necessary for root growth. If filled with water all the time (anaerobic activity), roots suffocate and drown.

Capillary Porosity is the percentage of pores filled with water after gravitational drainage.

Field Capacity is the amount of water held in a soil type's pores.

TIP: Ideally, at field capacity 50% of pores are filled with air, 50% are filled with water.

Available & Unavailable Water
Available water is the portion of water that can be sucked out by plant roots in the root zone.
Unavailable water is the fraction that remains too strongly bonded.

Permanent Wilting Point is reached when you get down to only that water too strongly bonded to be absorbed by the root system.

TEXTURE, PARTICLE SIZE, AND INFILTRATION
The particle size of a soil/sand based root zone mix influences the size of voids or pores between soil particles.

Smaller particle size = smaller pore void.

Pores formed between clay particles are very small and absorb water with so much energy; it is often unavailable to plants. Pores formed between sand particles are typically large enough for water to drain via the force of gravity. Pores between silt particles retain water against gravity, but plants can still absorb this water.

TIP: For soils, size of sand fraction becomes increasingly important as percentage of sand in soil increases. Best size choices for a sand-based mix are medium and coarse sized fraction.

Adhesion: Water molecules stick to each other.
Cohesion: Water molecules stick to soil or organic matter.

TIP: The deeper the profile, the more suction created to pull air down through the profile. Shallow profiles stay wet, deep profiles drain more thoroughly.
INfiltration
Process of water entering soil. Rate of infiltration is the maximum velocity at which water enters the soil surface. Healthy soil has continuous pores to soil surface, which allows water to enter unimpeded during a rain or irrigation event.

Low infiltration rate is often produced by surface seals. Surface seals are caused by weakened soil structure and clogged or discontinuous pores from oily deposits and/or compaction of incompatible soil layers. (Such as sod laid over a different soil type with no core aeration.)

Classic Percolation Test
- Dig a pit 1 ft deep.
- Fill with water, allow to drain completely.
- Refill, measure depth of water, note time.
- After 15 minutes, note depth of water and calculate rate of drainage in inches/hour.

Poorly drained: less than 4”/hour
Moderately drained: 4-8”/hour
Excessively drained: more than 8”/hour

Factors Influencing Soil Infiltration

Texture: Sandy has greater infiltration rate than clay.

Crust: Soils that have many large surface connected pores have higher intake rates than soil with only a few pores. Water hitting bare soil over focal compaction can result in a crust which seals pores and restricts water entry. Crust can also be covered with algal mat or result in a lens of water that encourages annual bluegrass.

Compaction: Leads to ponding or run off.

Aggregation and structure: Soils with stable, strong aggregates such as granular or blocky soils have a higher infiltration rate than massive soils or platey soils.

Frozen surface: Greatly slows or prevents water entry.

Organic matter: Plant material dead or alive increases the process of infiltration by protecting soil aggregates from breaking down during impact of raindrops. If soil aggregates break up on impact of precipitation, those particles that are broken off clog pores and seal the surface thus decreasing infiltration during precipitation.

Pores: Discontinuous pores may retard flow of water due to entrapment of air bubbles. Earthworms increase amount of pores and assist process of aggregation that enhances water infiltration.

Water content of soil: Infiltration rate is higher when soil is initially dry, then decreases as soil becomes wet. As pores and cracks become filled with water, soil with clay will also swell. As soils wet, they slow in infiltration rate to the rate of permeability of the most restrictive layer.
### Hydrological Soil Group

<table>
<thead>
<tr>
<th>Hydrological Soil Group</th>
<th>Infiltration Rate (inches/hr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A: Low runoff potential and high infiltration rate = Sands and gravel</td>
<td>1-8.3</td>
</tr>
<tr>
<td>B: Moderate infiltration rate when completely wetted = Sandy loam with moderately fine to moderately coarse textures</td>
<td>0.5-1</td>
</tr>
<tr>
<td>C: Slow infiltration rate when thoroughly wetted = Silty loam soils with an impeding layer or soils with moderately fine to fine texture</td>
<td>0.17-0.27</td>
</tr>
<tr>
<td>D: Clay soils with high swelling potential, soils in a permanent high water table and shallow soils over nearly impervious material</td>
<td>0.02-0.10</td>
</tr>
</tbody>
</table>

### STEADY INFILTRATION RATES FOR GENERAL SOIL TEXTURES

<table>
<thead>
<tr>
<th>Soil Type</th>
<th>Steady Infiltration Rate (inches/hour)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sands</td>
<td>Greater than 0.8</td>
</tr>
<tr>
<td>Sandy and silty soils</td>
<td>0.4-0.8</td>
</tr>
<tr>
<td>Loams</td>
<td>0.2-0.4</td>
</tr>
<tr>
<td>Clayey soils</td>
<td>0.04-0.2</td>
</tr>
<tr>
<td>Sodic clayey soils</td>
<td>Less than 0.04</td>
</tr>
</tbody>
</table>

**TIP:** Ways to Increase Infiltration
- Decrease compaction and crust formation by maintaining turf cover.
- Increase organic matter.
- Decrease or eliminate tillage operations. (Raking and leaf blowing are a kind of tillage, and increase surface rooting via compacting soil surface through organic material removal and soil packing.)
PART FOUR: Topsoil Suitable for Landscape Use

Never buy soil without inspecting it first. In many cases it is easier and less expensive to improve existing soil than to buy topsoil.

Considerations for Bringing in Topsoil

If you MUST bring in soil, it is important to consider:

- Soil texture
- Organic matter content
- pH
- Soluble salts

THERE IS NO OFFICIAL OR LEGAL DEFINITION FOR WHAT IS COMMONLY REFERRED TO AS TOPSOIL. A practical definition is the top 6-10” depth to which soil is plowed or cultivated. This layer differs from those beneath by having higher organic matter content, darker color, better tilth, high biological activity, and possibly less compaction.

TIP: Fertility can always be fixed. This is not always true of physical properties.

Desirable Ranges and Textures for Sand, Silt and Clay in Purchased Topsoil

- Sand: 40-65%
- Silt: 25-60%
- Clay: 5-20%
- Gravel content: less than 10%

Examples of soil textural classes that are desirable are: sandy loams, silt loams, and loams.

Organic Matter Values for Desirable Topsoils

- Sandy loam: 1.25-3% OM
- Silt loam: 2.5-5% OM
- Loam: 2.5-5% OM

Salt Levels for Desirable Topsoils

Quality topsoil should have less than 0.5 mmhos/cm for a soluble salts test using a 1:2 soil to water ratio.

ASTM Standards for Topsoil

- 2% by weight of fine textured stable organic material and no greater than 6%.
- Not less than 20% fine textured material passing through the #200 sieve and not more than 15% clay.
- Relatively free of stones over 1.5” in diameter, and less than 10% gravel by volume. (With no noxious weeds.)
- Do not use topsoil with greater than 500ppm soluble salts.
- Distribute to a uniform depth and NOT over partly frozen, muddy, or frozen slopes or over ice, snow, or standing water puddles.
- Topsoil placed and graded on slopes steeper than 5% shall be promptly fertilized, seeded, mulched, and stabilized by tracking with suitable equipment.
### Site Conditions

<table>
<thead>
<tr>
<th>Site Conditions</th>
<th>Intended Use</th>
<th>Minimum Topsoil Depth</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deep sand or loamy sand</td>
<td>Mowed lawn</td>
<td>6”</td>
</tr>
<tr>
<td></td>
<td>Tall legumes, unmowed</td>
<td>2”</td>
</tr>
<tr>
<td></td>
<td>Tall grass, unmowed</td>
<td>1”</td>
</tr>
<tr>
<td>Deep sandy loam</td>
<td>Mowed lawn</td>
<td>5”</td>
</tr>
<tr>
<td></td>
<td>Tall legumes, unmowed</td>
<td>2”</td>
</tr>
<tr>
<td></td>
<td>Tall grass, unmowed</td>
<td>none</td>
</tr>
<tr>
<td>6” or more: silt loam, loam, silt</td>
<td>Mowed lawn</td>
<td>4”</td>
</tr>
<tr>
<td></td>
<td>Tall legumes, unmowed</td>
<td>1”</td>
</tr>
<tr>
<td></td>
<td>Tall grass, unmowed</td>
<td>1”</td>
</tr>
</tbody>
</table>

**TIP:** For ANY addition of soil, after areas are brought to grade: prior to dumping and spreading topsoil, loosen subgrade soil by discing or scarifying to a depth of at least 2” to permit bonding of topsoil to subsoil.

### Improving Soil Structure Through Amendment

Organic matter is the best structural improvement for soil.

- You want to maintain 4-5% OM by dry weight in your soil.
- Increasing OM in an acre of topsoil by just 1% requires 40-50 cubic yards of amendment (or 460lbs/1000sqft for a 7” profile of topsoil).
- You need to have soil tested by a lab to determine OM. They burn it off and measure the levels by before and after weights.

Organic matter is important because it increases water holding capacity of soil. Organic matter holds up to 4-6 times its own weight in water. Since many nutrients are dissolved in water, this means nutrient holding capacity increases as well.

**TIP:** Completely broken down organic matter is humus: the stable end product that has a negative charge which holds onto and exchanges positively charged cations like potassium, calcium and magnesium.

This acts as glue for soil aggregates, the fibrous support hose that keeps air and water exchange going for better drainage, root penetration, and development. It serves as home and food for microbial populations involved in mineralization, nitrogen fixation, and disease control.

### Ideal Levels of Organic Matter

As a goal, most soils should be managed to maintain organic matter levels of at least 4-5% dry weight. Increasing organic matter in an acre of soil by just 1% requires the addition of 20 thousand pounds of humus or 40-50 cubic yards of material. 5.5-8% is ideal. Soil with 5% organic matter holds 1.88 gallons of plant available water in every cubic foot of soil.
**TIP:** When you are spec'ing out a manufactured soil, stay away from high organic silt loam or similar soils. While they LOOK like straight organic matter, they actually have 20-60% organic matter rather than 85% or greater. This means fine soil particles that clog up soil pores.

**ADDING COMPOST**

Addition of 10-30% by volume of compost to a soil will increase organic matter 2-5% by weight. Ideally this is mixed in offsite or rototilled in to a depth of 8-10”.

**Compost as Organic Amendment**

Always do a phytotoxicity test. Compost may have contamination issues such as salts (of particular concern with Kentucky bluegrass), and it may have gone anaerobic, which leads to very low pH and toxic compounds.

**Phytotoxicity Test:**

- Try growing tomato, cucumber, or watercress seeds in some of the compost using 5 or 6 trial cups.
- Compare these to seeds grown in identically treated cups with soil you know is okay.
- If seedlings reach the two-leaf stage, then suddenly yellow and shrivel in your compost test cups, you know something is wrong.

**GUIDELINES FOR IDENTIFYING HIGH QUALITY COMPOST**

- **Color:** Brown to black
- **Odor:** Earthy or moldy (never vinegary or like a cow burp)
- **Moisture:** 15-25%
- **Water holding capacity:** 150-200%
- **Bulk Density:** 0.2-0.6 g/cc
- **Organic matter:** 25-80%
- **pH:** 5.5-7.5
- **Ash:** 20-65%
- **Nitrogen:** 0.4-3.5%
- **Phosphorous:** 0.2-1.5%
- **Potassium:** 0.4-1.5%
- **C:N ratio:** 25-30:1
- **CEC:** 50-150 meq/100 g

**Ranking Compost by C:N Ratio:** When organic matter is added to soil, a C:N ratio of 15:1 to 30:1 is preferred. If you have a C:N ratio of LESS than 15:1, this suggests a compost not finished and/or presence of ammonia.

**WHAT ARE THE CAUSES OF SOIL COMPACTION**

- Normal use
- Excessive use (not enough area for number of users)
- Improper soil for intended use of site
- Poor construction techniques
- Poor mixing
- Poorly drained sites / outlets for drainage
- Excessive use while soil is wet
- Deep compaction during construction (big equipment syndrome)

**Hallmarks of Compacted Soil:** Look for platy or weak structure, massive clods, greater penetration resistance, higher bulk density, restricted plant rooting, and flattened, turned or stubby plant roots.
TIP: Important Compaction Facts
- Compaction may extend to 20” deep.
- Deep compaction affects smaller areas than shallow compaction, but persists because shrinking, swelling, freezing, and thawing affect it less.
- Machinery with axle loads of more than 10 tons may cause compaction below 12”.

Effects of Compaction on Soil Pores: Discontinuities in air and water inhibit roots from growing uniformly and may often FAIL to penetrate downward through a layer of contrasting texture even if that layer is less than 1”. Thus it is important to core aerate 4-6 weeks after putting down sod.

KINDS OF AERATION
- Spiking: Short-lived, least surface disruption (slicing/spiking are NOT aeration)
- Solid tine
- Hollow tine
- Deep tine
- Shatter tine: Fractures hardpan subsoil, promotes deep watering and active root growth

The best results are achieved when plugs are not dragged back in. This is especially true for aeration in autumn, when freezing and thawing over the winter will decompact soil further. It is important to NOT drag cores back in spring, this will also drag crabgrass seed and annual bluegrass seed over surface. Turf takes 2 weeks to recover.

TIP: Best timing: September and April, or once before and once after high traffic season.
TIP: The best aeration removes soil when making hole.
TIP: The best time to core is one day after a normal rainfall or irrigation.
TIP: Most compaction is in the top 1-3”, keep core holes open as long as possible.
TIP: If soil is very hard, core aerate, irrigate, repeat.

Aeration Must Be Combined With TOPDRESSING
- Remediate with organic matter to change soil structure.
- Compost is the best topdressing, it can increase infiltration of clay soils by tenfold.
- Use 1/4” to 1/8”, 4 or more times per year.
- Never jump up to ½”, this will cause yellowing and density loss.

SOIL LAYERING, STRATIFICATION, AND COMPACTION BY LAND LEVELING
If subsoil restricting layers are present before leveling, they will be shallower in cut areas and deeper in fill areas. To prevent a bathtub from occurring, rip layers before leveling.

The leveling process can cause stratification, because materials of varying textures are brought in to make the fill. The fill then becomes compacted because of the large amount of wheel traffic running over it.

For this reason, after final grade is achieved, deep tillage by ripping, slip plowing, disc, or moldboard plowing in some combination should be used to loosen compacted soil and mix stratified areas.
Effects of Compaction
The most serious effects of soil compaction are usually found between the surface and 15” deep, or up to 24”. Large moldboards, disc plows, rippers and chisels all move soil to a depth of 18-24” and should provide relief, if moisture is such that soil crumbles rather than clods.

Remember, loosened soil is especially prone to recompaaction if equipment is driven over it. If possible, freshly plowed soil should not be disturbed for several weeks. Alternate wetting and drying, especially by rainfall, will allow soil to settle gradually and help strengthen its structure.

Ripper and Chisel Specs
• For loosening compaction, you want a depth capability of 2ft.
• Curved or parabola shaped shanks are effective.
• Rippers pull more easily through moist soils, but do a less effective job of loosening.
• Ripping dry soils usually results in more effective loosening.
• Shank spacing should be equal or less than the depth of ripping.
• Ripping never breaks the soil straight across between the points of adjacent shanks; there is always a hump between two channels.
• The further apart the shanks, the higher the hump.
• Cross ripping lowers the hump. Parallel ripping at narrow shank spacing is more efficient than ripping and cross ripping at a wider spacing.

Soils with Natural Restricting Layers
• Usually these layers are DEEP, so require special equipment. Make sure you are not inadvertently creating restricting layers by monkeying with soil. Deep restrictive layers usually only need to be remediated once.
• Shallow restrictive layers will probably need multiple remediations because they tend to reform due to human practices.

Causes of Natural Stratification
Natural Stratification is: Layers of different soil textures with abrupt boundaries between layers caused by speed of movement of floodwaters.

Rapidly moving water deposits coarse sand and gravel

Slowly moving water deposits fine sand and silt

Still water deposits clay.

Precipitation does not move uniformly downward in stratified soils. Think of pouring brandy on a layered cake; how does it penetrate through the layers?
• Fine layers under coarse layers slows rate of water movement so it remains ponded in the coarse layer above. This is a perched water table, resulting in poor aeration of plant roots in the coarse layer above the fine layer.
• The same result is achieved if the fine layer is above the coarse layer. The tiny pores hold on to the charge on water and the water molecules hold on to each other’s charges
How to Proceed if you have Natural Stratification
Deep plowing with a moldboard blow or disc plows will break up and mix stratified layers. Best to do twice, but may not be able to get in immediately after first plowing so may have to wait a year. These two methods penetrate 18-30”

To go deeper, use a slip plow to go 5-6ft. This only mixes soil in the trench it has made. 15% of total soil profile gets mixed, and not as well as with the mold board or disc.

Best management practices include the slip plow followed by moldboard or disc plowing.

TIP: Poorly drained soils are more prone to compaction due to the lubricating effect water has between soil particles.

DRAINAGE
Surface drainage: Needed to prevent puddles forming on soil surface, and that which has already percolated through the soil.
Subsurface drainage: Needed when water percolates through topsoil faster than natural subsoil drainage will allow, causing a perched water table.

TIP: You can tell if you need surface drainage or subsurface drainage simply by walking into a puddle. If it is firm underfoot, the problem is surface drainage. If you sink to your ankle, it’s a sub-surface issue.

You can also do a test boring. If water infiltrates from the sides; it’s a surface drainage problem. If you have a high water table, subsurface drainage makes sense. More often what happens is formation of a perched water table at a depth where it will impact the turf roots. (I.e. the upper 10.) This is primarily a subsurface compaction issue.

Drainage and the Perched Water Table
If you have coarse soil over fine soil: Water moves through the coarse layer quickly, hits the slower draining fine layer below, and begins to back up into the coarse layer.

If you have fine soil over coarse soil: Water moves very slowly through the fine layer and cannot get to the coarse layer, until the fine layer is completely wet up. Only then can it overcome the attractive charges between water molecules and the sides of the small pores, and between the water molecules themselves.

TIP: A common thought is: you need a firm base, and then a “drainage” layer. So you use “select fill”, i.e. gravel and road material compacted to 100%, and put 4” of “best quality” topsoil atop that. THAT IS A PERCHED WATER TABLE RECIPE!! START OVER!!

Common Signs of Trouble in the Root System
• Layering in soil profile
• Inconsistent blending of soil amendments
• Uneven soil depth
• Black layering
• Compaction
• Poor root development
Evaluating Drainage: The worst drainage and erosion problems are from November-April. Selection of planting or building site and water control systems should be based on this “wet season.” Do test borings from your site that are from 3-5ft deep during the wet season. Take these borings at the highest elevation on the plot, in depressions, and at the bottom of abrupt slope changes. If you see obvious ponded or spongy areas, take borings in these areas as well.

A soil with good internal drainage has a high proportion of sand or gravel, and will NOT have distinct layers but will show a gradual color change from dark to light at 3ft depth. You should see no free water during excavation. Plants will have a deep, uniformly distributed root system.

Dealing with Roof Runoff so it does not ruin your Planting Plan
1. Deflect away from foundation, spread on lawn if there is enough slope to prevent ponding.
2. Start a rain garden.
3. Connect downspouts directly to a footing drain or storm sewer.
   - Best choice is to have excess water go to a gravity outlet to a storm sewer or drainage ditch.
   - Second choice is a drainage system that has gravity flow to a sump or reservoir where water can be pumped elsewhere.
   - Dry wells are the worst choice for getting rid of excess water in soils with restricted internal drainage.

TIP: In an area with GOOD drainage, if area of lawn is at least 10 times area of roof or other paved areas, you don’t have to connect downspouts to an underground drainage system.

Recognizing Bad Drainage
A soil profile with abrupt color changes and mottling within 3ft of the surface indicates a restrictive soil layer, which inhibits downward movement of water. Soil will look densely packed and free water will accumulate in test boring holes of less than 3ft if bores are taken during wet season. Water will look like it is oozing into holes near the densest looking layers.

TIP: Restricted internal drainage occurs on slopes of 10% or greater as well as on flat surfaces.
TIP: Surface wet spots often appear at the base of slopes and will remain wet until mid-summer. Particles roll down hill.

Recognizing REALLY Bad Drainage
- Restricted vs. poor internal drainage
- Dark surface soil with an abrupt change to light gray or brown mottling
- Usually seen in natural depressions or in flat areas
- May also see in areas with seepage or runoff from higher elevations
- See large populations of sedges, willows, alders, red maples
- If you dig a test hole in wet season, hole rapidly fills with water and may not dry until late summer.
- This is the area to install your pond or wildlife marsh.

Drainage Indicator Plants
- Indicator of poor drainage sites: Willow, pin oak, swamp white oak, tupelo
- Indicators of moist soils: Sycamore and tulip trees
- Indicators of well-drained sites: Sugar maple, red oaks, hickories
Troubles with Bedrock
- Bedrock close to surface can cause drainage problems. (Shallow vs. deep profile and gravity-suction effect.)
- Bedrock below 8-10ft generally causes no problems.
- Bedrock at less than 8ft generally causes the soil profile to dry out rapidly so it is hard to maintain turf and other ornamentals.
- Free water flows along natural cracks in rock. If there is an abrupt change in slope get seepage on the land below the rock outcropping.
- Look for nearby road cuts to show you the local depth of bedrock or use soil survey.

Improving Surface Drainage
Grading or crowning. (Be careful; compaction, compaction, compaction.)
Crowning, for example, on a football field: 12-18” crown (1-2% sloping uniformly) from center to sidelines where tile lines are placed with open catch basins to remove surface runoff.
Vertical trenching to improve surface drainage: Dig trenches 12-18” deep and 3” wide on 10-15ft centers. If a slope exists in the area, run trenches ACROSS to remove runoff. Trenches should be sloped 0.5-1% to a terminal outlet which can include already existing drain tile. Use 2” ID slitted drain tubing in the bottom of the trench, then backfill to overflow with WASHED SAND. (Be careful of dirty or disreputable sand.)
- Herringbone and lateral drainage designs are common subsurface drain patterns.
- Drainage tiles are normally placed 2ft under turf with 15-20ft spacings.
- Trenches should be 6-8” wide with a minimum of 0.5% grade.
- Place a 2” layer of pea gravel in trench then level to grade for tile placement.
- Place 3-4” corrugated drain tiles into the prepared trench.
- Cap blind ends and secure all joints to prevent influx of soil particles into drain.
- Backfill trenches with a 2-4” layer of pea gravel over tile and fill remainder of trench with the soil mix you will use as your final growth media.
- AVOID filling trench with pea gravel to within 4” of surface, this will actually reduce draw of the tile leaving the surface wet.
- NO DRAIN FABRIC!!!!! Plugging and particle migration is a disaster.

**TIP:** If no drain tile is available, the trench can be terminated with a surface drain where you end the slitted tubing with a T joint set vertically. Extend the opening to the soil surface to allow outflow of excess water.

**TIP:** You don’t need subsurface drainage unless you have a several days persistent water table after precipitation, or soil is continuously saturated, or if said water table is more than 3ft below root zone.

French Well for Drainage
Impermeable layers sometimes overlie permeable. By placing a vertical or French well through the layer you can speed drainage. Dig a hole with a 12” auger through the impermeable layer and backfill to soil surface with pea gravel.

Cambridge System for Drainage
Basically a lateral system, an overlain grid pattern of sand filled trenches connected to subsurface drains. Requires a special contractor with the right equipment to install subsurface drains and vertical sand filled slits cut into surface.
PART FIVE: The Menace of Manufactured Soils
Manufactured soils are blends of soil, soil components and soil-like material used in horticulture/landscape applications and site restoration. Using manufactured soils allows for “tailoring” of soil properties to specific needs. For example, a potting mix for seedlings may need to be light and well drained to accommodate seedling roots and reduce transport costs. In contrast, a landscape blend may need to be heavier and have a larger mineral component to provide long-term support and nutrition for trees/shrubs.

The theory: Take sub-soils, sand, and composts to generate a soil that performs equal to or better than native topsoils. Components of manufactured soils range widely. Typical components include: Compost, sub-soil, dredge, sand, shredded bark, and other organic materials. All bagged topsoils and gardening soils sold in commercial establishments are manufactured soils.

How do we classify Manufactured Soils?
Manufactured soils can broadly be divided into two categories consisting of:

1. Topsoil mixes (planting soils)
2. Structural soils.

The specifications for these soil blends are usually provided by the landscape architecture firm that designed the urban garden. These special soil blends are commonly created from non-local soil materials blended with manufactured or processed inorganic ingredients, such as sand or expanded shale. Ideally, they include a certain percentage of native soil salvaged on site or harvested from a nearby location.

Structural Soils
Structural soils differ from topsoil mixes in that they are designed to provide an engineering function as well as support plant growth. They typically consist of a blend of mineral soil with a coarse aggregate (stone) and thereby form a highly porous (30–35%) matrix with a high load-bearing capacity and rapid infiltration rate that also allows root growth and development.

- They are designed to provide structural support (i.e., load-bearing soils) beneath paved areas like sidewalks, streets, plazas, and parking lots while at the same time providing additional rooting space for trees beyond the traditional planting “pit” or “cutout.”
- The structural component of these manufactured soils can consist of crushed stone, as in the Cornell University (CU) soil, or a light-weight heat-expanded shale or slate.
- CU soil is a mixture containing 80% (v/v) crushed granite or limestone rock and 20% clay loam soil.
- Another structural soil has been created by blending Carolina Stalite heat-expanded slate with a sandy clay soil at an 80:20 ratio.
- Increased strength and permeability in structural soils are achieved at the cost of diminished water and nutrient holding capacity.

What happens when you add Manufactured Soil to an Existing Soil Site?
Technosol: A class of human-impacted soils generally considered urban soils. We use the term urban soils to encompass use of natural, modified, or manufactured growth substrates in urban and suburban landscapes highly influenced by human activities.
**Urban Soil**
One of the most significant impacts of anthropogenic activities on urban soils is a change in the soil's physical functions. Urban soils often display a high degree of horizontal and vertical profile variability commensurate with the level of human disturbance. As a result of disturbance, the horizons of urban soils do not always run parallel to the soil surface, as observed in their natural or slightly modified counterparts.

Construction is the predominant human activity leading to truncated soil development and creation of discontinuous layers in urban soil profile because it usually involves scraping, cutting, filling, and spreading of soil.

Urban renewal and greening projects, more common near city centers, typically face degraded onsite soil conditions. Plans to modify/replace onsite soil must be on a case-by-case basis.

Physical compaction resulting in increased bulk density is a widespread problem with urban soils. As in agricultural soils, compaction destroys the natural structure of urban soils, resulting in reduced porosity with fewer or no macropores. Compaction also limits the movement of water through the soil profile, which can contribute to increased storm water runoff.

**Use of Manufactured Soils: Urban Settings**
The practice of making major modifications to available soil resources or manufacturing soil blends is almost exclusively an urban phenomenon. In these situations, the basic principles of soil science, including the concept that soil inputs should improve or sustain soil quality and long-term productivity, are usually NOT a major consideration.

**Onsite Manufacture of Soils**
Manufactured soils are generally used where there is no onsite soil or the onsite soil is unsuitable for use due to physical or chemical contamination.

Topsoil mixes are usually made by mechanically blending a mineral base like subsoil or sand, with organic materials like compost or peat, sometimes with the addition of lime and fertilizer.

Blending can be accomplished in situ by tilling a 5-15cm layer of organic matter into the existing soil, by mixing the ingredients in a tub mixer, or by folding together materials with front-end-load tractors.

In some cases, the onsite soil has to be significantly modified by mixing with various amendments to restore ecological functions and create a site-specific property, such as rapid infiltration and drainage.

Drainage is a very important concern in urban landscapes due to the pervasiveness of impervious surfaces.

In most urban situations, the existing onsite soils do not have the ability to drain at rates that help mitigate storm water runoff, therefore, organic and inorganic amendments are added to “manufacture” a soil with the desired property.
APPENDIX

MAINTAINING LOW MAINTENANCE, LOW INPUT LAWNS
The essentials to reduce turf stress and to commit to a low input lawn:

- Keep grass at a 3” height.
- Switch to endophytic and/or best grass for your site.
- Remove grass where it simply cannot grow in a low input situation (shade, severe compaction, tree roots, etc.) Switch to something that can grow, or a mulch.
- Implement recommended irrigation changes or updates, and know irrigation outputs on a zone by zone basis. Understand the system and any limitations.
- Leave clippings on lawn.
- Eliminate edging of lawn.
- Allow leaves to be mulched into lawn as much as possible.
- Routinely test pH.
- Know soil texture and organic matter level.
- Routinely supplement to keep pH and organic matter in correct range.
- Never expect 100% green.

If you do not wish to do these things, low input lawn care may not be for you!
SCOUTING BY THE CALENDAR

January/February

- Test pH and soil texture, apply lime IF NECESSARY depending on test results.
- Scan site for bare areas and dormant seed. (Rye germinates at soil temp of 45°, tall fescue at 55°. Measure soil temp with standard meat thermometer.)
- Check for areas of snow build-up over unfrozen ground. Remove to lessen chances of snow mold.
- Rake out chickweed and dormant seed.
- Check that you have a minimum 4” of existing topsoil covering the subgrade: this may vary over the field.
- Scan for areas of poor drainage and note for further observation.

March

- Look to see which areas green up first---these may be localized areas of compaction. To test, use a screw driver (not right after rain) and see how far into the soil the hilt will easily go. Core aerate focal areas of compaction rather than the whole lawn to avoid spring weeds, and top dress with 1/8" of compost. Remove cores.
- On first mowing, MOW LOW ONCE and reset mower for 3”. This initial low mowing will speed soil warming and spring green up. Mow early to also remove unsightly wild garlic/wild onion tops without disturbing actively growing grass.
- Check dormant seeded areas for germination, if necessary re-seed. Check for new areas that may need spot seeding due to weather or wear from early play.
- Check for signs of pink snow mold (circular gray or salmon colored spots) and rake out to hasten drying; usually a self limiting disease if precautions are taken in the fall.
- Look for areas with signs of leaf spot and record for further observation later on in the season, check the areas for thatch build up and record findings.
- Check for pythium root rot in thin, diffusely yellowed, stunted turf occurring in areas of poor drainage or recently sodded spots. Dig a sample 4” wide by 3” deep and check for layering and root quality. If layering or poor roots, aerate these spots only and top dress with 1/8"compost or amend soil with reed sedge peat or composted brewery sludge which has some protective effect against pythium root rot. Pythium root rot causes massive decrease in volume and vigor of roots.
- Start checking soil temps mid-month in preparation for activity of annual bluegrass weevil.
- Look for yellow, circular areas which may indicate cool season brown patch. It is important to try to decrease moisture in affected areas.
- First crabgrass seedlings out with soil temps of 54-58° for 3 consecutive days, major emergence at soil temps of 68°.
April

- Look for areas invaded by weeds and be ready with a mix of fast sprouting rye seeds and compost for sunny areas.
- Perennial weeds will be coming up now, including dandelion, clover (more following a dry year, but it is shallow rooted and so is easily raked out), bent grass (more following a wet year), ground ivy (shallow rooted), oxalis, plantain, wild garlic, quackgrass, speedwell, and mugwort.
- Look for perennial nutsedge next month and into June.
- Quackgrass treated with an organic herbicide may need to be treated again, but before you do this, fertilize the quackgrass to push lateral buds out of dormancy and then hit it with your product again to get better kill. This is especially effective in springtime.
- Clover may be reduced by limiting excess phosphorous, but find out if clients can live with clover since it is good for the soil.
- If quackgrass or mugwort are problems, don’t till an infested area because it will spread the problem. If you are using organic herbicides for quackgrass control, fertilize the quackgrass following treatment to stimulate dormant buds, treat again to weaken the plant. Both mugwort and quackgrass may respond better to treatment in October than in April.
- Check for red thread outbreaks in areas with pinkish, straw, or reddish color; this is usually a self-limiting disease and proper fertility can reduce the incidence. The best amendment for red thread is composted poultry litter.
- Mid-April should see prophylactic treatment of areas prone to summer patch or necrotic ring spot by tax time.
- Continue to monitor for pythium root rot, leaf spot and cool season brown patch and use suggested strategies to combat; leaf spot is very common this month due to wet weather but again it is self-limiting unless dealing with a few varieties of bluegrass that may go on to melting out.
- Scout areas of turf preferred by birds, for grub activity. Do NOTHING about grubs at this time since they are not in a susceptible life stage and do comparatively little feeding at this stage, but note what areas of the yard they were in so you can re-scout those in the second and third weeks of August.
- Scout now for germinating summer annual weeds like crabgrass, goosegrass, purslane, spurge, blackmedic and knotweed. Pull or treat, remove, re-seed.
- Check for crabgrass emergence when soil temperatures are 54-58° for 3 consecutive days. USE A MEAT THERMOMETER.
May

- Scout for presence of progressive leaf spot decline (look closely at dead leaves in thinned out areas for signs of spots, especially in areas of rye exposed to deicing salts), for smut, for red thread, which may come and go ( overseed in fall with resistant varieties), and pythium root rot. If pythium root rot suddenly becomes a problem, check for changes in drainage due to compaction or grading.

- Now that trees are leafed out, evaluate shade: grass needs 6 hours of at least 50% sunlight to thrive; try to get rid of grassy areas that don’t receive this; shady areas should receive half the normal amount of fertilizer to limit disease UNLESS it is a high traffic area.

- Necrotic ring spot in new turf can be improved using uncomposted animal or plant meals or composted poultry litter.

- Turf is under greater stress where shading occurs in winter, for example objects on north side of turf cast long shadows, turf never really dries out.

- Take photos of problem areas through the season. You may be surprised at what the shadows can tell you.

- Plant growth regulators may improve turf appearance in shady areas but will also make turf more disease-prone

- Need at least 50% sunlight (minimum 4 hours daily) for turf to survive, 6 hours to thrive, morning light is better.

- Shade tolerance: Cool season: ff>bentgrass>rough stalk blue grass>KBG shade tolerant (eclipse, bensun, birka, bristol, glade, nugget, touchdown)>TF>KBG intolerant>PRG.

- Check turf under trees for water stress because the tree canopy excludes rainfall and the water that makes it through is used by tree roots.
June

- Monitor for chinch bugs in sunny or sandy areas using 1 ounce lemon dish soap to 1 gallon water overlain with a 1ft square piece of nappy white flannel. If found in concentrations about 1 nymph/square inch or 125/sqft consider treating. A permanent solution is to overseed areas affected by chinch bugs with endophytic fine fescue or ryegrass in September.
- Start monitoring summer patch; look for frog eyes or swirly areas of tan grass.
- Continue post emergence pursuit of weeds; look to see if mowing high has reduced previous history of prostrate weeds and annual bluegrass.
- Dollar spot is a common turf disease easily spread on mowers and shoes. Lesions are easy to see with the naked eye; they look like hourglasses. You can overseed with resistant varieties; but check for thatch buildup in areas prone to dollar spot. Core aerate these areas well in the fall; increase air circulation. You may need to remove clippings from seriously affected areas in order to prevent spread to other sections of the turf.
- In areas hit hard on a yearly basis; best amendments for dollar spot include uncomposted animal and plant meals and composted poultry litter.
- Monitor for Aschochyta leaf blight which may provide some silering of grass tips which turn inward and take on a pointed appearance; the disease is self limiting and is often the result of over fertilization; regular compost may have some protective effect if applied as a light topdressing.
- In late June begin to look for sod web worms, although they are unlikely to be a problem on turf with plenty of ants to act as predators, or turf in shade.
- Look for the beginnings of anthracnose, especially when it turns hot and dry.
- Look for algae.
- Continue to monitor for leaf spot melting out, red thread early in month, if pythium root rot or nutsedge appears, check irrigation for leaks as well.
- Look for presence of adult beetles flying around, look for Japanese beetles, European chafers, Asiatic garden beetles, oriental beetles; several of these are attracted to light so recently installed outdoor lights may jump up your populations.
- Post emergent weed problems should be handled as before.
- Moles may be repelled using castor oil products; multiple applications may be necessary.
July

- July is a major disease month under the correct environmental conditions.
- Although red thread will usually fade from the scene you can add brown patch, fairy ring, and anthracnose to your monitoring list.
- Brown patch will usually subside as soon as PM temperatures drop below 65°, but for a particularly susceptible lawn, amendment with uncomposted animal and plant meals or with composted poultry litter may suppress the disease by 75%, coupled with improvement of drainage. (I.e., core aerate the area in fall.)
- Try very limited amounts of oak sawdust as soil amendment to reduce brown patch.
- Areas in early AM where no dew has formed may have brown patch.
- Adult beetles should be subsiding by mid-month; continue to monitor for chinch bugs and sod web worms in wilted or browned areas or areas aggressively picked at by birds.
- Moles can sometimes be repelled using castor oil products.
- Tap rooted weeds such as dandelions grow better in compacted soil.
- If you see green algae on leaf blades it indicates poor drainage.
- Bird, skunk, or raccoon damage early in month especially near or under trees is likely due to cicada nymphs underground, as it’s too early for grubs to be present. Reseed or re-sod areas.

August

- Mid-August is grub scouting time; look for areas that appear to have drought stress or are being aggressively picked at by birds.
- How to scout for grubs: take 3” wide by 3” deep samples about every 10ft in a grid pattern, map findings. Wherever you have 1 or more grubs in two adjacent plugs you have a hot spot. Sample further around the hot spot, spot treat as recommended below.
- If grubs are present, identify what kind they are and sample to find exact margins of trouble spots and that you have reached a threshold of 10 grubs/sqft.
- If you need to treat, pre-water site with ½” of irrigation and then post-water the site with ½” after you have applied, to push the product down. Continue to monitor for sod web worms and chinch bugs. Adult sod web worms don’t necessarily indicate a problem because of efficient predation on eggs. They will also never reach populations high enough for damage if turf is in the shade. Adults don’t cause feeding damage.
- Begin to evaluate lawn for possible renovation at end of the month or beginning of September; if the area contains at least 50% turf, you can overseed. More than 50% weeds means total renovation.
- Diseases to monitor for are the same as in July.
- Scout now for germinating winter annuals like chickweeds, Italian rye, and annual blue grass. These weeds have shallow roots and can easily be removed.
- Look for spread of moss.
**September**
- Diseases: Time for red thread to come back, along with rust, which while unsightly is usually a self limiting disease. Increase air circulation to reduce rust. Dollar spot will persist through this month as well.
- Note where crabgrass is now, map locations for overseeding now or in spring.
- This is a good month to overseed and renovate.

**October**
- Scout areas that have not filled in from last month’s overseeding or renovation. These will fill in with weeds next spring, so either reseed them early in October, or mark them for dormant seeding in late February and early March.
- Diseases to scout for include red thread, leaf spot, and rust, especially along sides of buildings or in areas with low light intensity and poor air circulation.
- Scout for sprouting biennial weeds early in the month, such as curly dock and Queen Anne’s lace. Use a weed popper or soap or vinegar based product for removal.

**November**
- Core aerate one week before last mowing, leave aeration holes open, take away cores, topdress with a ¼” of compost; this will help decrease weeds the following season.
- Cut grass short on last mowing around last week of November to prevent grass lying over and inviting snow mold.
- If you have a problem with snow mold, reduce amount of fast release nitrogen used at final fertilization; this is also better for the ground water. Also reduce potassium applications, this also makes snow molds worse.
- Use seaweed based products according to labeled rates as drought conditioner for following year. Potassium in these products may also help deter diseases.

**December**
- You can dormant seed bare areas. Use 50% more seed to compensate for bird predation and rot.
- Mark out areas that went into winter dormancy thin, or areas you can see crabgrass skeletons: these will be areas to target for dormant seeding in February and March, the first areas to get crabgrass, and if compacted, annual bluegrass the following spring.