There are two formulations of pHAcid . pHacid Sprayable and pHacid Injectable both are safe acids meaning they will not harm turf ,people or equipment.

pHacid spryable and injectable are affordable.
When all the cost are included, pHacid sprayable and pHacid Injectable formulations are a better value than many of the organic acids claiming to reduce calcium bicarbonates. The use rates on the organic acids formulation are very high.

pHacid sprayable is safe to use on turf for both cool and warm season grasses.
pHacid Spryable Will not BURN ; even in high temperatures.
pHacid Sprayable has been applied in temperatures exceeding 100 F on both cool and warm season grasses.

pHacid Sprayable use rate is 1 to 2 oz. per 1000 sq., ft. spray in a 1 to 2 gallon spray solution. Phacid sprayable application frequency is dependent on the PPM level of the calcium bicarbonate and other bicarbonates in the soil profile. If the calcium bicarbonate PPM is under 150 PPM, use phacid sprayable at 1 oz. per 1000 sq. ft. monthly. If the calcium bicarbonate level is 150 PPM or higher apply phacid sprayable at 1 oz. per 1000 sq. ft. every two weeks as the temperatures start to increase thru out the mid spring and summer months. If the calcium bicarbonate PPM are over 300 then spray phacid sprayable at the 2 oz. per 1000 sq. ft. every two weeks from mid spring thru out the summer months.

pHacid Sprayable has a wide tank mixing capabilities

It is important to remember that as the ET rates increase the

more irrigation water applied that is contaminated with high levels of calcium bicarbonate – a good rule to remember the frequency of application is more important as the rate of phacid sprayable.

pHacid sprayable is more concentrated than pHacid Injectable – pHacid sprayable is for treating the soil profile – pHacid Injectable is for treating a water column thru injection strategy.
pHacid Sprayable is not corrosive to equipment.

pHacid Injectable is designed for use thru an irrigation system. It will reduce the irrigation water pH and help reduce the amount of insoluble bicarbonates reaching the soil profile thru irrigation events.

The use rate of pHacid Injectable is 1 gallon of pHacid Injectable to every 25,000 to 30,000 of irrigation water being applied.

pHacid Injectable is not corrosive to equipment. A pulse monitor pump will be able to inject pHacid Injectable.

RECLAMATION / TREATMENT OF SODIUM- BICARBONATE AFFECTED SOILS IN COMBINATION WITH HIGH pH WATER SOURCES CONTAMINATED with BICARBONATES

Soils can be problematic for two reasons. The soils are already contaminated with both sodium and calcium bicarbonates and the water is contaminated. As the summer heat approaches the need for treatment is more pronounced thus the reason to start the program early to reduce the PPM levels of the problem salt buildup.

WATER SOURCES

SO WHERE DID THE SALTS COME FROM?

Over 80 % of the water sources in the U.S have high bicarbonates levels.

80 % of the water sources in the US market are problematic = meaning they are above the 150 PPM level in calcium bicarbonates.

Effluent water sources are generally at the 150 PPM level : and others. plus other contaminates such as , chlorides, sulphates

General rule : effluent water sources are good water sources.

WATER SOURCES

- Water quality and natural soils makeup are a sources of salt problems
- Unless source of salt problem can be eliminated or reduced, reclamation / treatments is more difficult due to consistent irrigation injection programs and COST
- Imperative to have water and soil samples analyzed regularly
- Sodium, carbonates and bicarbonates in source water present major concerns for turfgrass manager
- Frequent applications of reclaimed, effluent, or recycled sources of water will contribute significantly to accumulation of salts and heavy metals – consistent programs – then COST

Always get a water analysis, it is a must in putting in place a program for turf managers.

The cost of application of phacid sprayable is about $20.00 per acre.

phacid Sprayable is the MOST effective acidification tool available for turf managers. At $20.00 per acre the for the high value areas on a course it is a small cost factor.

SODIUM-AFFECTED SOILS

Under conditions where sodium ions, carbonates and bicarbonates dominate the soil water solution, sodium-affected soil conditions will develop.

Sodium ions are one of the most limiting ions in turf soil chemistry

High levels of Sodium and Calcium bicarbonates in both irrigation water and soil profiles are very limiting to turf nutrition and nutrient availability.

SODIUM and CALCIUM BICARBONTE AFFECTED SOILS

SOURCE

The water source can be the major contributor to the salt effected soils.

SODIUM and CALCIUM BICARBONTE AFFECTED SOILS

Irrigation water containing high levels of sodium, bicarbonate and carbonate = precipitate calcium and ions as calcium carbonate and calcium bicarbonate.

Once calcium ions are tied up in insoluble carbonate forms, sodium then becomes more dominant in the soil and water matrix. ACIDIFICATION is the KEY!

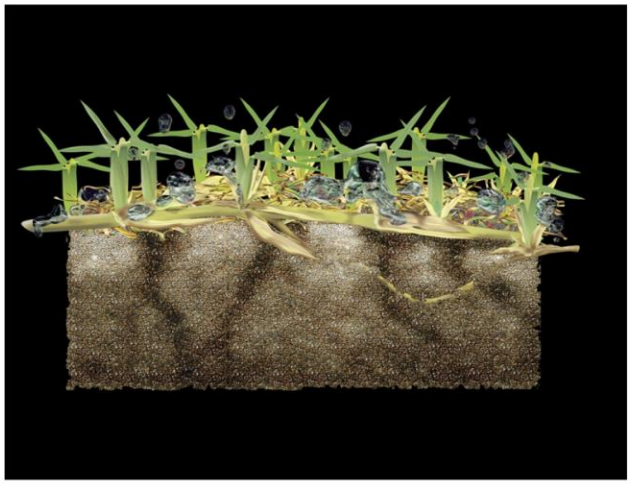
Sodium ions will replace calcium (or magnesium) ions on the clay particle surface.

What phacid sprayable does best is CREATING A SAFE ACIDIFICATION EVENT in soil profiles. Because of its high acid value, phacid sprayble it is the best at the acidification process. To reduce bicarbonates in a soil profile it is a must that a safe acidfication event happens to make SOLUBLE the insoluble calcium bicarbonate molecule, once soluble the calcium portion of the calcium bicarbonate is now soluble calcium and the co3 portion will be lost to volatilization.

Once you have soluble calcium then the sodium to calcium exchange can happen more effectively.

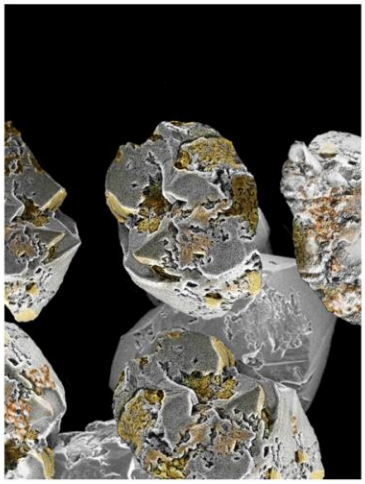
IMPORTANT = Once calcium bicarbonate is soluble now you can create a very efficient FLUSHING EVENT!

ADDRESSING SODIUM and BICARBONATES IN TURFGRASS SOILS



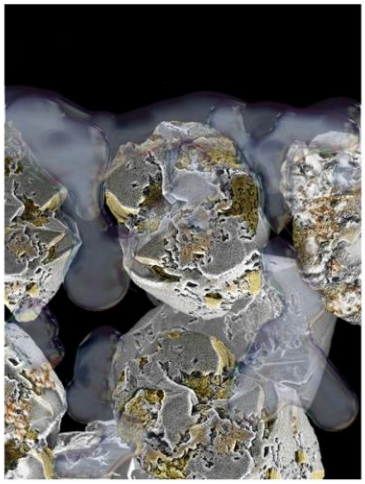
Here we have soil profile that has very restrictive infiltration and penetration due to the blockage of the micro-pores. When sodium and /or bicarbonates build up in the soil profile it clogs , blocks the micro pores soil spaces and greatly restrict the water flow downward – over time this blockage will make water that is applied to “sheet’ and not penetrate into the soil. The term many turf managers will use is my “soils are hard” ! A great sales lead that there “salt” concerns!

Let’s look a bit closer to get a better idea of what we have to address.

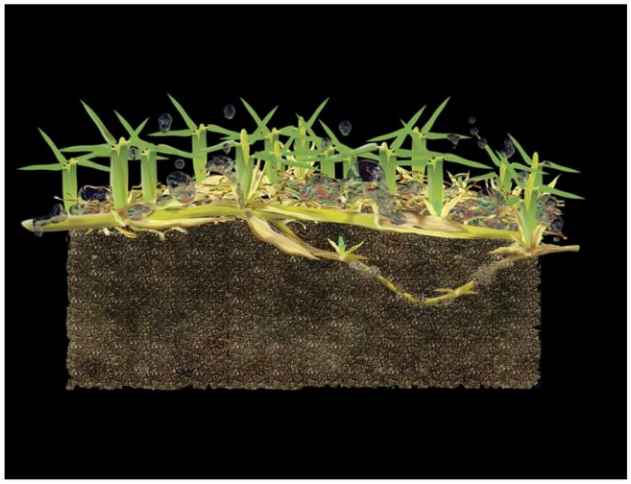


1. Here we have a highly enlarged depiction of a typical green soil profile consisting primarily of sand particles.
2. Note the open pore spaces , especially the micro pore spaces – open pore spaces provide infiltration and penetration of water movement without restrictions.
3. 2. NOTE: the open pore spaces in the soil profile. Allowing water infiltration and penetration downward thru the soil profile. NO restriction of water flow.

2. Click to next slide

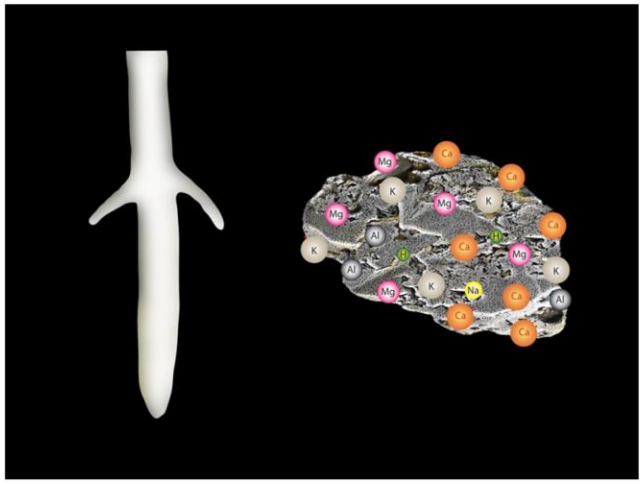


1. When water is applied, it should move in a uniform wetting front that supplies and refreshes water supplies in order to accommodate turf plant demands.
2. Click to next slide.

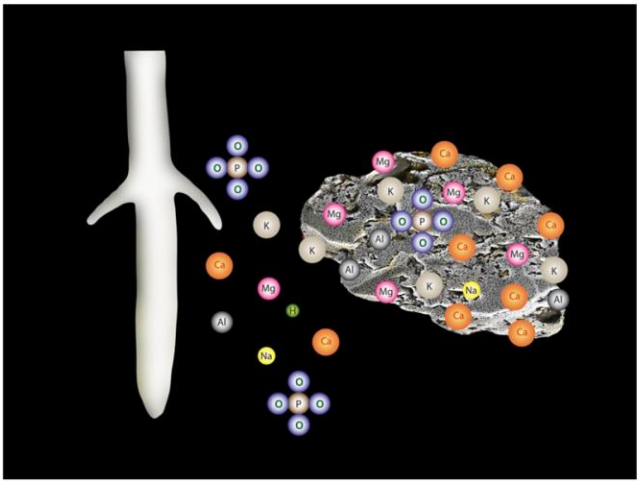


1. This is a depiction of a turf profile with a highly uniform moisture content.
2. All is well…all is good.
3. Click to next slide.

1. Water also provides the carrier for essential elements such as calcium, potassium, magnesium, phosphorus as well as plant nutrients.
2. Click to next slide.

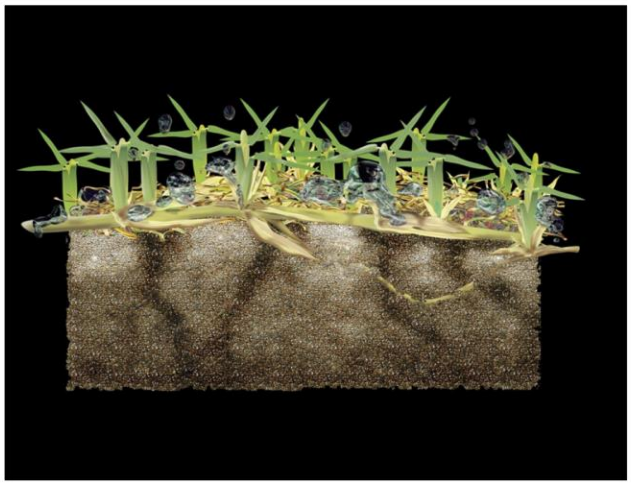


1. A number of key positively charged elements (cations) are attracted to negative sites on soil particles.
2. As the cation load builds on soil particle surfaces, some will move into the soil solution and become available to the turf plant.
3. Click to next slide.



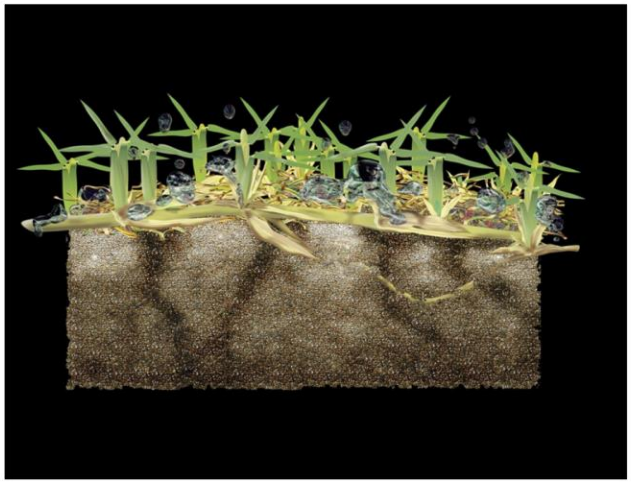
1. This is the basis for cation exchange capacity – C.E.C.
2. Calcium will typically occupy 50-70% of the cation exchange capacity.
3. Calcium and magnesium serve to maintain the structural integrity of clay-containing soils.
4. All continues to be well and good.
5. However in many parts of the country, not all is well and good.
6. Click to next slide.

CARBONATES IN TURFGRASS SOILS



1. Irrigation water that contains high concentrations of salts such as carbonates and sodium can be highly problematic for golf course superintendents.
2. These conditions can occur naturally, but unfortunately, much of the effluent or reclaimed water being required throughout the country contains high levels of sodium, bicarbonate and carbonate ions.
3. Alkaline soils with high pH (>9) can contribute to poor soil structure and low infiltration capacity.
4. Click to next slide.

CARBONATES IN TURFGRASS SOILS

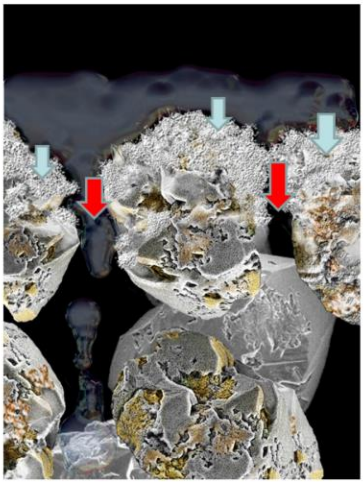


1. These soils often have a hard calcareous layer at the surface that can extend several inches into the soil.
2.This slide sows the bubbling (an acid) applied to a section of turf containing a high level of alkalinity (highly basic).
3.Click to next slide.

CARBONATES IN TURFGRASS SOILS

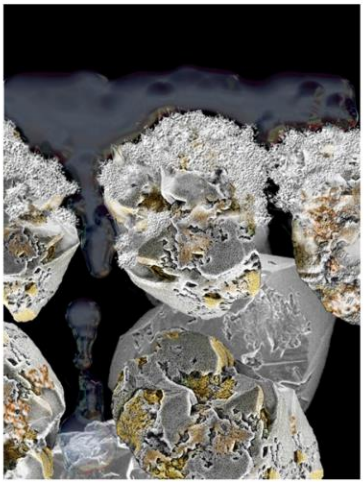
1. Once again, let's look closer to appreciate what we're up against with alkaline soils.
2. Click to next slide.

CARBONATES IN TURFGRASS SOILS



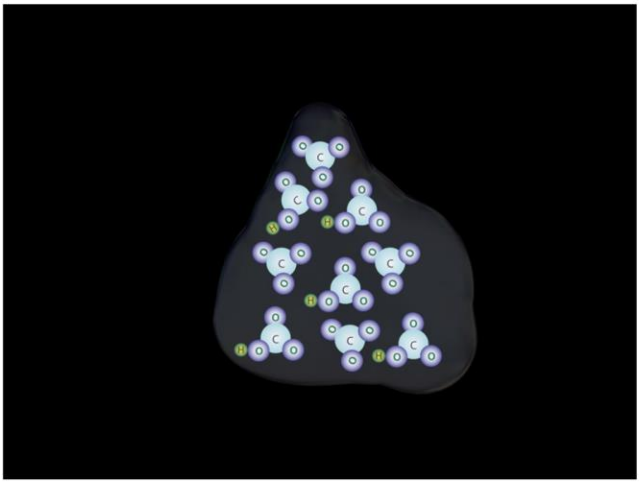
1. To make matters worse, as carbonate and bicarbonate-based compounds dry and are exposed to heat, they can form “crusts” on the soil surface –limiting / restricting water penetration and infiltration of water.
2. Click to expose arrow.
3. Further, uniform movement of water through the soil profile is often restricted and/or compromised as soil “cementing” restricts or closes off pore spaces.
4. Click to expose arrow.

pHAcid Mode-Of-Action



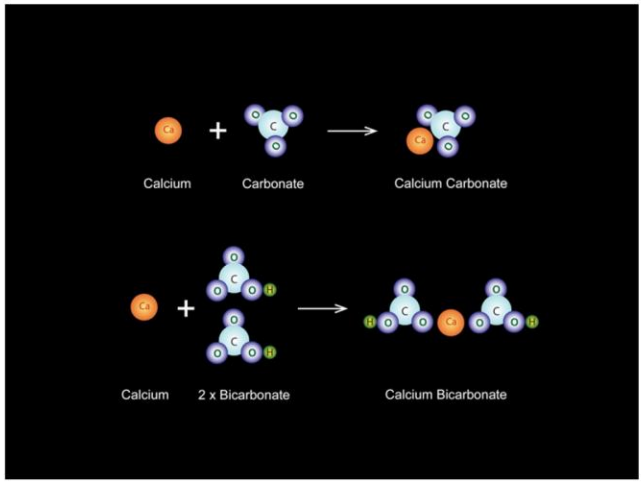
1. pHAcid's reaction with calcium and magnesium carbonate and bicarbonate molecules is highly effective in removing "crusts" on soil surfaces.
2. Click to next slide.

CARBONATES IN TURFGRASS SOILS



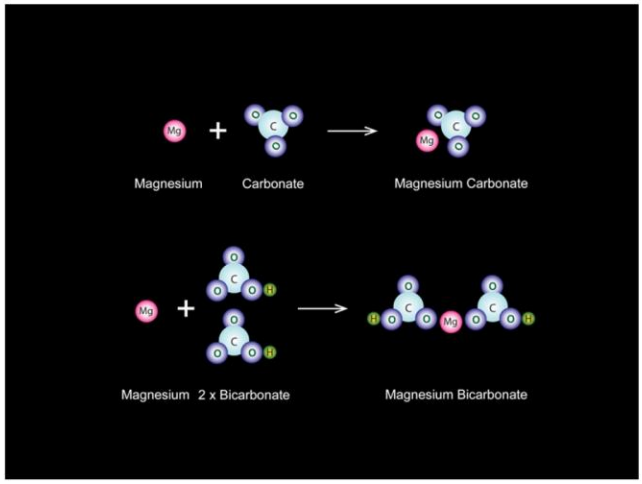
1. **Here they are, right in front of you – carbonate and bicarbonate molecules** taking a ride through the soil in your irrigation water.
2. These “beastly critters” have the capacity to form a number of reactions with other elements and molecules – none of which is particularly good for your soil.
3. Click to next slide.

CARBONATES IN TURFGRASS SOILS



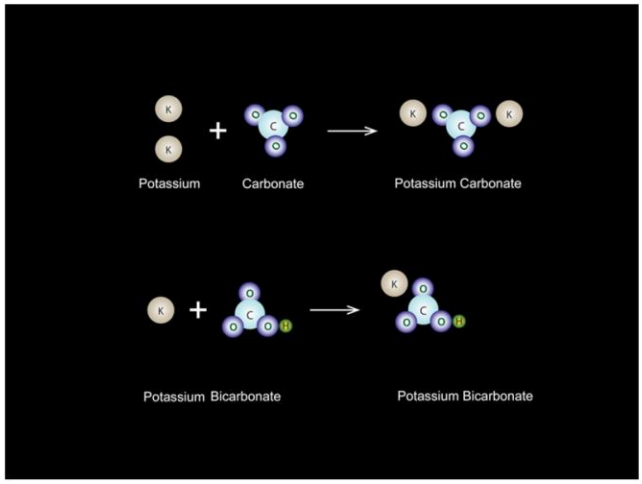
1. Carbonates and bicarbonates are highly attractive to Calcium where they quickly form Calcium Carbonate and Calcium Bicarbonate.
2. These reactions occur both in the soil solution as well as on the surface of the soil particles.
3. Click to next slide.

CARBONATES IN TURFGRASS SOILS



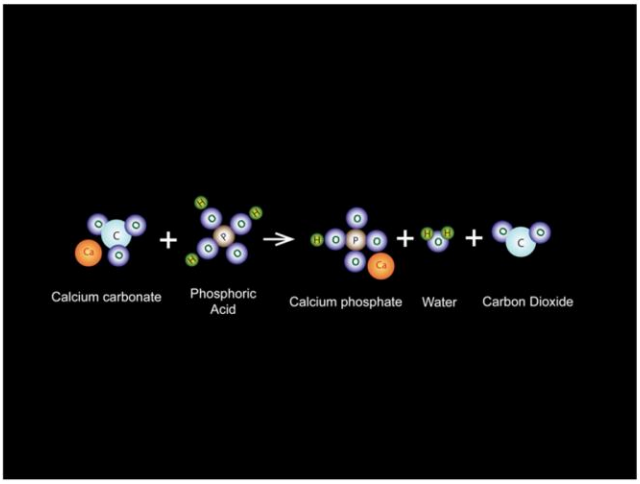
1. Magnesium is similarly attractive to carbonates and bicarbonates, form identical reactions as they do with calcium.
2. Click to next slide.

CARBONATES IN TURFGRASS SOILS



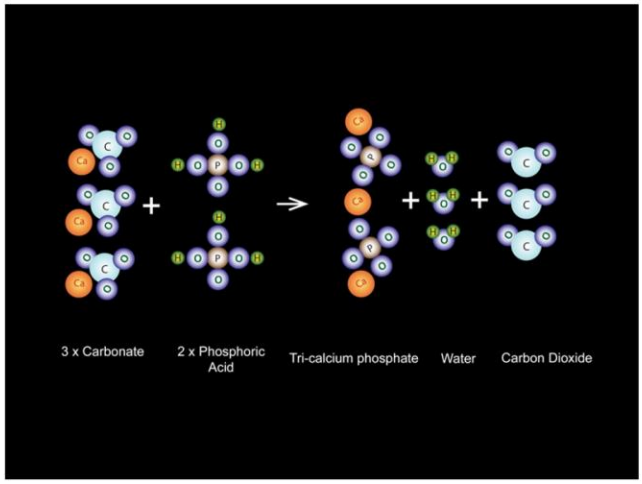
1. Potassium is yet another cation that bound by carbonate and bicarbonate reactions.
2. Now let's look at the devastating effect of carbonate and bicarbonate reactions are to phosphorous availability.
3. Click to next slide.

CARBONATES IN TURFGRASS SOILS



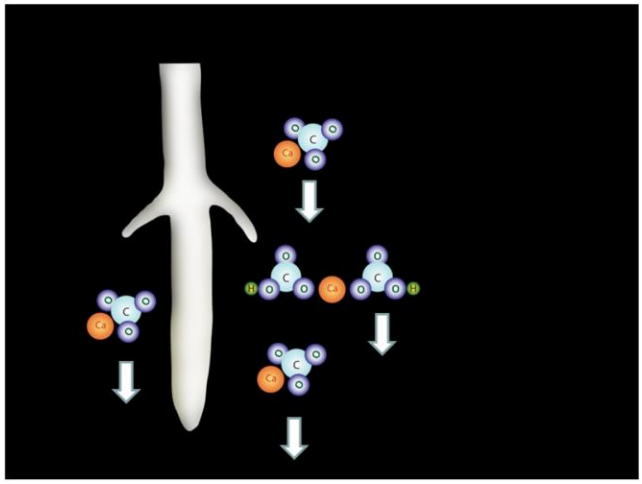
1. Calcium carbonate, formed by the reaction of calcium and carbonate reacts with “free phosphorus” – phosphoric acid – to form calcium phosphate, water and carbon dioxide.
2. In effect, completion of this reaction now ties us both calcium and phosphorus and neither element is available for plant uptake or use by soils for structural integrity. This can and does result in the breakdown (deflocculation) of soils, encourages precipitation of organic matter and reduces permeability.
3. Click to next slide.

CARBONATES IN TURFGRASS SOILS



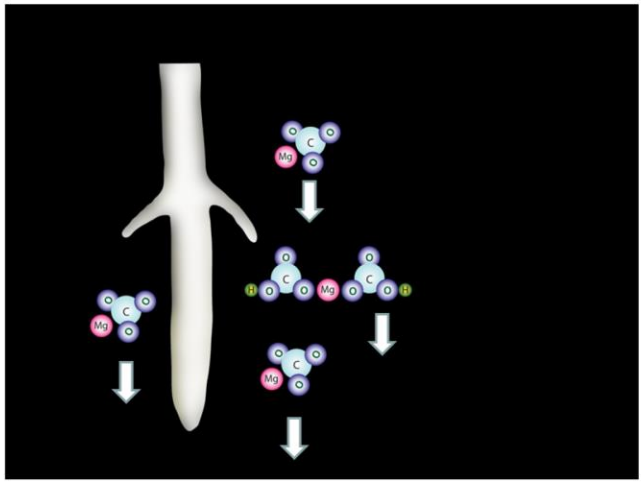
1. But the calcium carbonate and phosphoric acid reactions can be even more complex --- involving even more calcium carbonate and phosphorus molecules.
2. As more calcium reacts with phosphoric acid, the more insoluble the phosphates become.
3. Click to next slide.

CARBONATES IN TURFGRASS SOILS



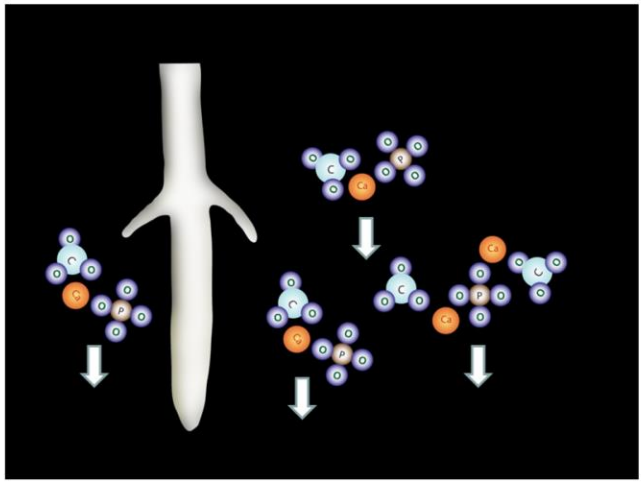
1. In the soil solution, all these reactions result in precipitates that move the insoluble compounds throughout the rootzone.
2. Here we see calcium carbonate and calcium bicarbonate precipitates moving from the rootzone.
3. Click to next slide.

CARBONATES IN TURFGRASS SOILS



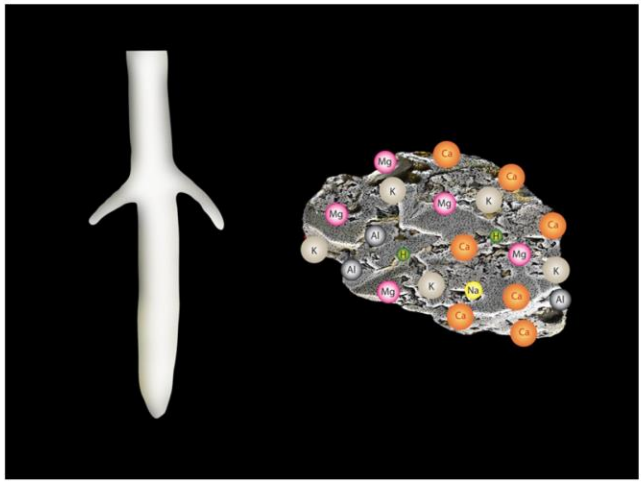
1. The same goes for magnesium carbonates and magnesium bicarbonates – depriving the roots of these valuable elements.
2. Click for next slide.

CARBONATES IN TURFGRASS SOILS



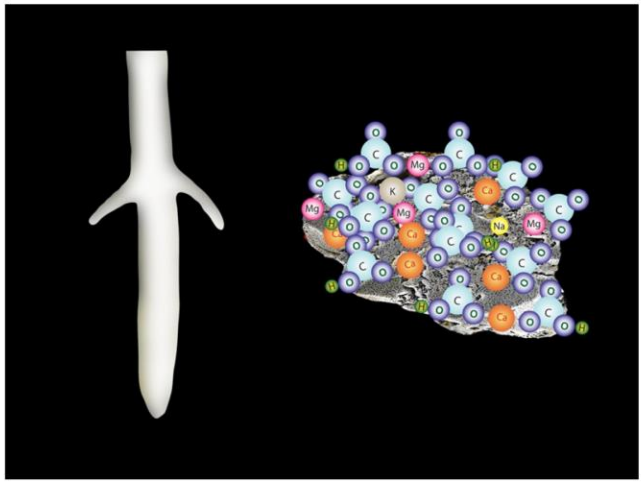
1. If phosphorus wasn't hard enough to keep in the rootzone, carbonate reactions make it even more difficult to supply this element.
2. Click for next slide.

CARBONATES IN TURFGRASS SOILS



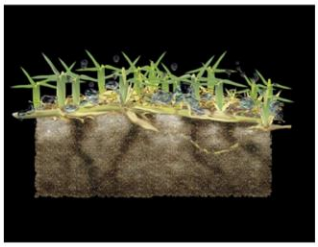
1. So what about cations on soil particles that contribute to the cation exchange capacity of the soil?
2. Click for next slide.

CARBONATES IN TURFGRASS SOILS



1. Carbonate and bicarbonate reactions literally bind valuable cations such as calcium, Mg, K and P to the particle surface.
2. Turf plants suffer from lack of essential cations.
3. Click to next slide.

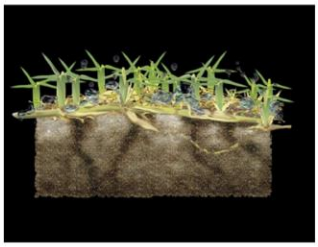
CARBONATES IN TURFGRASS SOILS



- Soil conditions with high pH (>7.0)
- Bicarbonate levels that exceed 150 ppm (>150 mg/L)
- Poor water movement into and through soil profile

1. So let's review what we're dealing with alkalinity in turfgrass soils.
2. Click and ready summary bullet points
3. Click to next slide

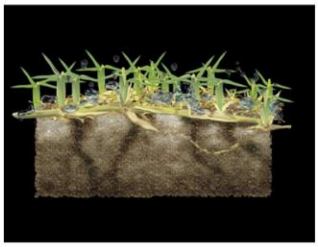
CARBONATES IN TURFGRASS SOILS



- Crusting at upper levels of soil profile
- Damage to structural integrity of soil if sodium levels are above 70 ppm (70 mg/L)
- Reduction in free calcium and magnesium (allowing Na ions to damage soil integrity)
- Lower CEC – reduction of nutrient availability

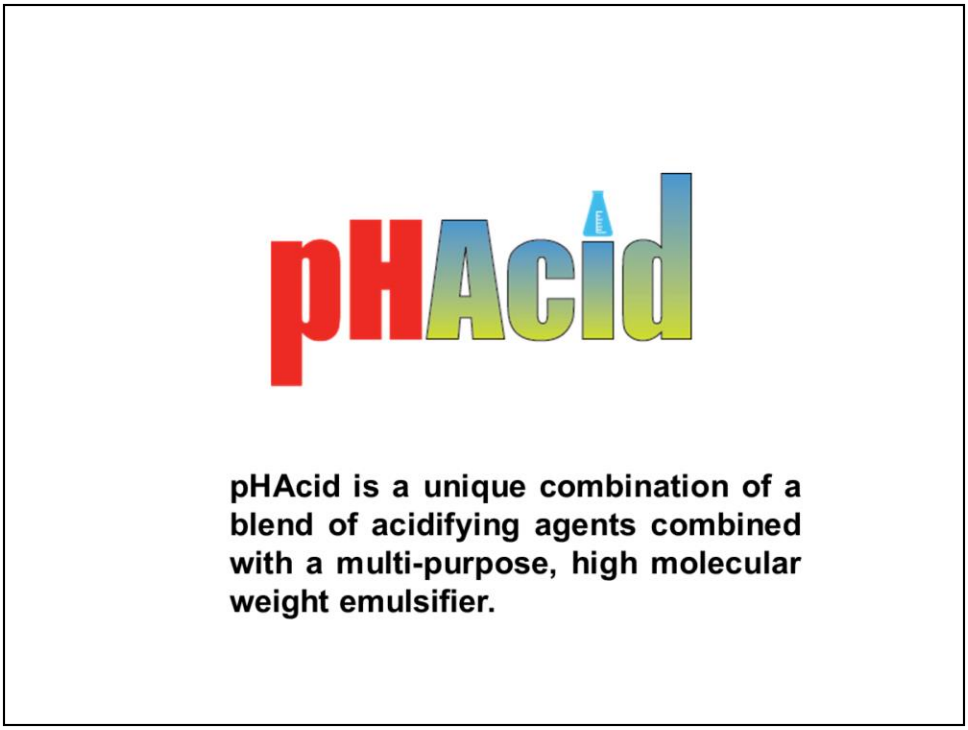
1. Click and ready summary bullet points
2. Click to next slide.

CARBONATES IN TURFGRASS SOILS

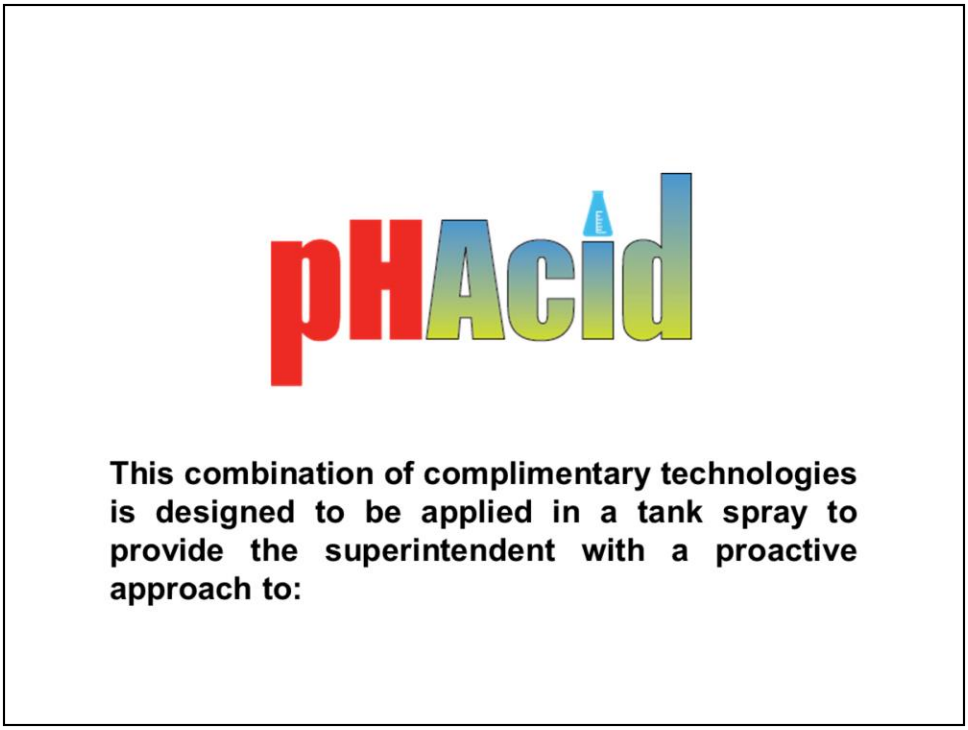


Today, many soil scientists suggest the use of soil amendments to reduce the carbonate threat in soils and reduce the pH.

1. Click and read TEXT
2. What is really needed is an SAFE ACIDIFICATION event in the soil. = phacid sprayable



1. Click and read text
2. Click to next slide



1. Click and read text
2. Click to next slide

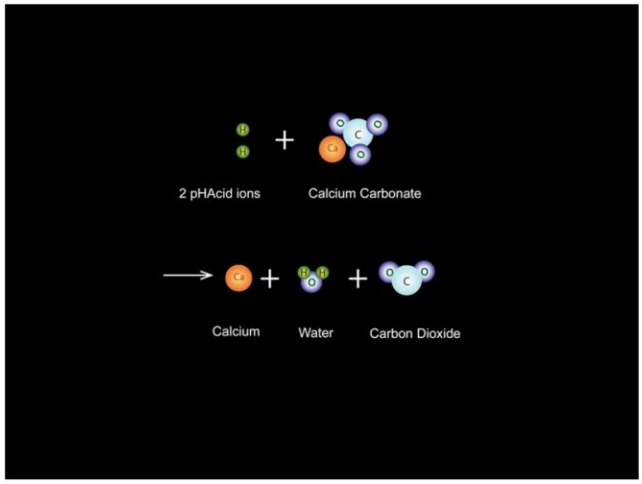
- **Neutralize the negative effects of high bicarbonate and carbonate levels in soil solution.**
- **Lower pH of soil water.**
- **Dissolve calcium carbonate and magnesium carbonate salts on the surface (crusts) and in the soil profile.**

1. Click and read text
2. Click to next slide

- **Maintain the solubility of Ca and Mg in soil water.**
- **Improve the ability of soil-applied Ca-based amendments to produce soluble Ca.**
- **Flocculate dispersed colloidal-sized clay particles.**

1. Click and read text
2. Click to next slide

pHAcid Mode-Of-Action



1. Click to reveal MOA and describe:
2. 2 pHAcid ions react with calcium carbonate and the result is calcium being “freed” from the calcium carbonate ion and water and carbon dioxide being formed.
3. Calcium is now fully available to strengthen soil integrity and increase soil fertility
4. Click to next slide.

CARBONATES IN TURFGRASS SOILS

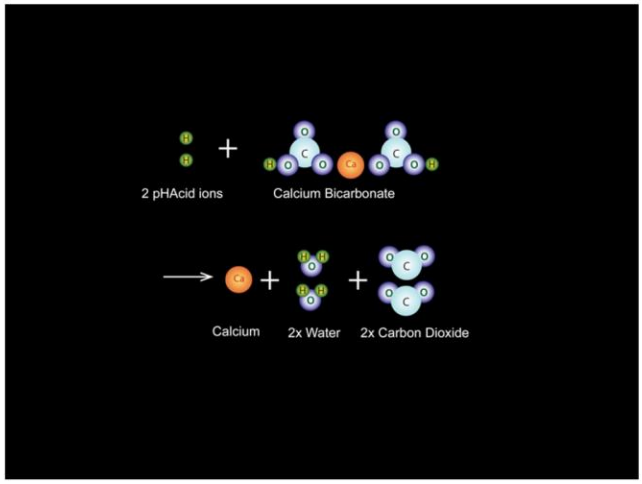
1. Click to reveal slide
2.“This slide sows the bubbling or “foaming” reaction carbon dioxide and water being released when carbonates in soil are treated with an high acid value product such as pHAcid Sprayable.
3.Click to next slide.

Release of CO_2 from the bicarbonate build up in the soil profile after

pHAcid

Picture of a demo using pHacid sprayable on a bent grass green that has very high calcium bicarbonate levels over 400 PPM. Once the green is saturated with Phacid Sprayable on water the chemical reaction starts - the soil core pulled early before treatment started the calcium bicarbonate is now made soluble provide free Calcium and the a complete flush is now achievable.

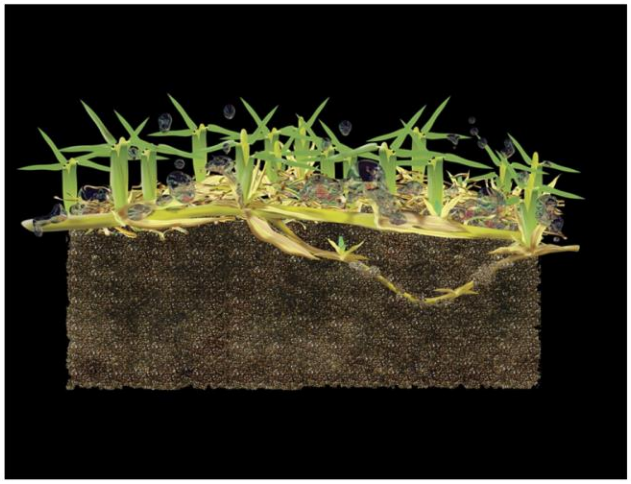
pHAcid Mode-Of-Action



1. Here we see pHAcid ions reacting with calcium bicarbonate.
2. It will react with other elements bound with carbonate molecules in a similar fashion.
3. This will free other cations such as potassium and phosphorus and make them available to the turf plant.
4. Click to next slide.

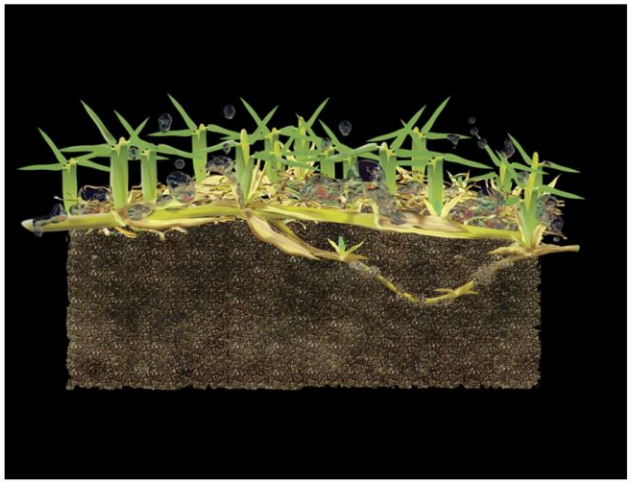
There have been several reports form the demos the last 2 years that pHacid sprayable will help reduce the Fairy Ring development – this maybe understand because fungal pathogens do not thrive in low pH solution environments.
Black Layer – pHacid Sprayable has been report in many demos to reduce the formation of Black Layer – again Black Layer is anaerobic condition with bacterium infections – Bacterium do thrive in low pH solutions and environments.

pHAcid Mode-Of-Action



1. The use of pHAcid has proven to be a very effective tool in programs designed to remediate bicarbonate affected soils.

QUESTIONS?



Any Questions?