

Mitigating the Effects of Poor Water Quality on Soil Chemistry

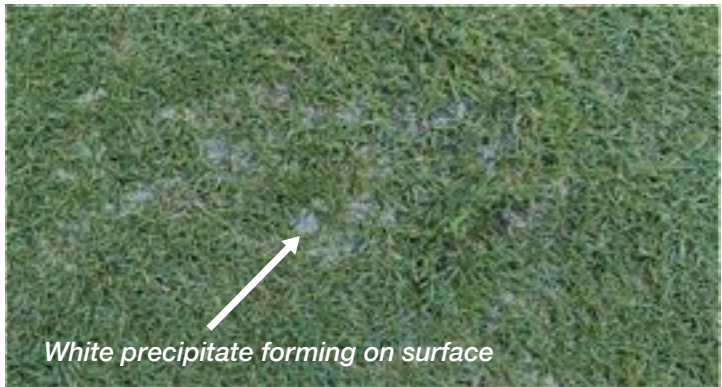
Our unique soil solutions are formulated with technologically advanced active ingredients, providing a set of agronomic tools for turf managers to achieve a balanced soil profile for healthy plant growth.



Understanding How Poor Water Quality Can Affect Your Turfgrass

Signs and Symptoms of Poor Water Quality

- Irregular TDR Meter moisture readings
- Chlorotic turf
- Poor infiltration of water (wetter surface)
- Turfgrass experiences wet wilt
- Difficult to rewet soils after dry-down
- Slow and poor response to turfgrass fertility
- Turfgrass will show effects of traffic wear
- Soil / Paste Extracts show unbalanced nutrient levels
- White precipitate forms on surface



How to Get Started on Developing a Treatment Plan

To Develop a Successful Treatment Plan We Must Understand Our Starting Point

Test your irrigation water - This will identify potential issues being added with each irrigation cycle.

Perform a standard soil test - This will identify levels of your exchangeable nutrients.

Perform a paste extract on same soil test sample - This will identify levels of your extractable nutrients. These are the nutrients that are readily available to the plant.

Important - Be sure to have your paste extract performed using your irrigation water. This will provide the most accurate picture as to how nutrients, soil and water are interacting.

Understanding Soil, Paste and Water Sample Results

Standard Soil Test - Exchangeable Nutrients

Parameters	Preferred Results
pH	6.2 - 6.8
OM%	1.0 - 4.0
Sulfur	< 40 ppm
Phosphorus	> 200 lbs / A
Calcium (Base Saturation)	> 2000 lbs / A (65%)
Magnesium (Base Saturation)	> 200 lbs / A (15%)
Potassium (Base Saturation)	350 lbs / A (3 - 6%)
Sodium (Base Saturation)	< 50 lbs / A (0.5 - 3%)
Hydrogen	10 - 15%
Iron	90 - 150 ppm
Boron	1.0 ppm
Manganese	30.0 - 50.0 ppm
Copper	3.0 - 10.0 ppm
Zinc	5.0 - 10.0 ppm

Categories of Importance When Evaluating Soil Report

Additional Notes on Soil Tests

pH and soil type will have a direct effect on your CEC or Cation Exchange Capacity.

Volume of Cations present are directly related to your CEC levels. The greater your CEC, the more Cations that can be present on the colloid.

Categories of Importance When Evaluating Paste Extract

Paste Extract - Extractable Nutrients

Parameter	Preferred Results
Bicarbonates	< 50 ppm
Soluble Salts	< 950 ppm
Chlorides	< 100 ppm
Sulfur	5.0 ppm
Phosphorus	1 - 2 ppm
Calcium (Base Saturation)	35 - 60 ppm (60%)
Magnesium (Base Saturation)	6 - 13 ppm (20%)
Potassium (Base Saturation)	13 - 20 ppm (13%)
Sodium (Base Saturation)	< 18 ppm (2 - 6%)
Boron	0.08 ppm
Manganese	0.10 ppm < 0.25 ppm
Copper	0.07 ppm
Zinc	0.10 ppm

Additional Notes on Soil Tests

Important to monitor your Paste Extract levels as this better represents what is immediately available to the turfgrass.

Important to keep levels of Calcium, Magnesium, and Potassium within range.

Understanding Soil, Paste and Water Sample Results

Categories of Importance When Evaluating Water Quality



Irrigation Water Tests

Parameters		Low	Medium	High	Problematic
pH		5.5 - 6.5	6.5 - 7.5	7.5 - 8.5	8.6 +
Carbonate (CO ₃)	ppm	< 10	11 - 25	26 - 39	40 +
Bicarbonate (HCO ₃)	ppm	< 20	20 - 70	71 - 119	120 +
Calcium	ppm	25 - 50	50 - 75	75 - 100	100 +
Magnesium	ppm	< 5	6 - 15	16 - 24	25 +
Potassium	ppm	< 2	3 - 6	7 - 10	11 +
Sodium	ppm	< 1	2 - 26	27 - 50	51 +
Nitrate - N	ppm	< 1	2 - 3	4 - 5	6 +
Sulphate - S	ppm	0 - 125	126 - 250	251 - 375	376 +
Phosphate - P	ppm	< 1	1.0 - 2.9	3.0 - 4.9	5.0 +
Zinc	ppm	0.10 - 0.20	0.21 - 0.40	0.41 - 0.80	0.81 +
Copper	ppm	0.05 - 0.10	0.11 - 0.20	0.21 - 0.30	0.31 +
Manganese	ppm	< 0.25	0.25 - 0.65	0.66 - 0.99	1.0 +
Iron	ppm	< 0.5	0.51 - 1.25	1.26 - 1.99	2.0 +
Boron	ppm	0.05 - 0.10	0.10 - 0.20	0.20 - 1.00	1.0 +
Chloride	ppm	10 - 25	25 - 50	50 - 250	250 +
Fluoride	ppm	0.30 - 0.70	0.70 - 1.20	1.20 - 1.99	2.0 +
Alkalinity	ppm	< 33	34 - 66	67 - 99	100 +
EC		< .50	0.51 - 1.25	1.26 - 1.99	2.0 +
Total Dissolved Solids	ppm	150 - 300	300 - 500	500 - 700	700 +
Sodium Adsorption Rate (SAR)		< 1	1.1 - 3.3	3.4 - 5.9	6.0 +

Understanding Solutions for Mitigation the Effects of Poor Water Quality on Soil Health

There are three main categories of water quality problems:

- Alkalinity
- Total Dissolved Solids (TDS)
- Electrical Conductivity (EC)

Through our AcidipHy and Verde-Cal Products, turf managers are provided a suite of Solutions that will synergistically aid in mitigating the effects of poor water quality on soil and plant health. Our true Acid based lineup offers the turf manager the ability to treat any area of their property with a wide variety of affordable options. Verde-Cal Products formulated with technologically advanced active ingredients will achieve a balanced soil for healthy plant growth.

Understand How Organic Acids Can Mitigate the Effects of Poor Water Quality



- Works best over longer period of time
- Beneficial application at time of aerification
- Best used to mitigate effects of poor irrigation water quality

Description

AcidipHy is a proven, effective and very safe slow release granular soil acid technology. One application of AcidipHy provides 10X the neutralizing capacity as compared to typical liquid applications with NO PHYTOTOXICITY. AcidipHy is also very economical as a localized treatment versus liquid injection into water systems which treat the entire course. End users can treat smaller problem areas without the need for expensive injection equipment. AcidipHy provides the added benefit of KEY essential nutrients to help fight stress and prevent disease to fine turfgrass and ornamentals.

Rates:

120 ppm Bicarbonate - 4 lbs per 1000 ft²
240 ppm Bicarbonate - 8 lbs per 1000 ft²
360 ppm Bicarbonate - 12 lbs per 1000 ft²
450 ppm Bicarbonate - 15 lbs per 1000 ft²



- Beneficial when needing immediate reaction
- Mitigates effects of Bicarbonates and Sodium in 24 hours
- Easy application through sprayer equipment
- Best used when mixed with OARS PS or Excalibur and soil is flushed with rain or irrigation

Description:

AcidipHy Liquid is a unique blend of acidifying agents combined with a surfactant and manganese sulfate designed to be applied through a tank spray. AcidipHy Liquid lowers the soil and soil solution's pH while utilizing and/or releasing soil nutrients that are present but previously not available to the soil or plants. AcidipHy Liquid enhances stress resistance by allowing the plant/soil to regain balance and release nutrients.

Rates:

Apply 1 to 3 ounces per 1,000 ft² in 1 to 2 gallons of water (3 to 9 L/ha in a 400 to 800 L) at 30 day intervals or as needed.

Irrigate with sufficient water to deliver AcidipHy L to the soil profile – 1/8 inch (3 mm) or more recommended.



- Combination of Acid and Penetrating Surfactant can mitigate effects of poor irrigation water quality when applied on a regular basis
- Low use rates permit multiple weekly applications if necessary
- Easy application through sprayer equipment

Description:

Acidi-pHlow is a blend of soil wetting agents combined with a unique blend of acidifying agents designed to enhance the penetration and infiltration of water with the added benefit of reducing the negative effects of high bicarbonate levels.

Rates:

Apply 1 to 1.5 ounces per 1,000 ft² in 2 gallons of water (3 to 5 L/ha in 800 L) at 30 day intervals or as needed.

Irrigate with sufficient water to deliver Acidi-pHlow to the soil profile – 1/8 inch (3 mm) or more recommended.



- Beneficial for injection of acid through irrigation system
- Mitigates the effects of poor irrigation water quality at the source
- Consistent use is required for best results
- Low use rates allow for an economical solution

Description:

pHlow-ject is an injectable soil acidifier designed to lower the pH of the soil solution and enhance the infiltration of water applied through irrigation systems. pHlow-ject is a blend of soil wetting agents combined with a unique blend of acidifying agents and is compatible with all conventional irrigation systems.

Rates:

Inject 1 to 2 quarts per acre (3 to 5 L/ha) at 7 day intervals or as needed.

Balancing Soil is More Than pH!

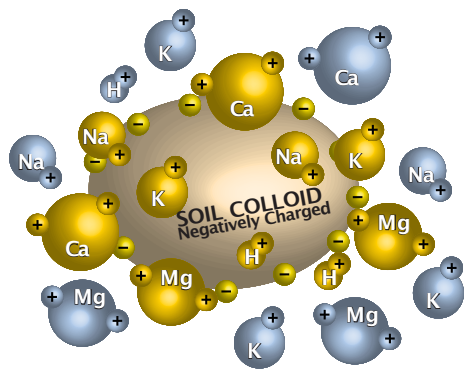
A building block for healthy turfgrass is to have a balanced soil. Many factors go into what a healthy soil looks like. Most turf managers look at only Base Saturation and the 5 Cations. Everyone needs to remember how water quality effects the plant available nutrients. Paste extracts are an important test to determine how the plant available nutrients are negatively influenced by poor irrigation water quality. In doing a saturated paste extract test it is important to use your irrigation water instead of distilled water in order to get an accurate picture of your overall soil health.

The Cation Exchange Complex

The process of cationic exchange begins when water and basic cations (Ca, Mg, K, Na) meet the soil colloid. Based on the soil colloid's degree of cation affinity, Calcium (Ca) will attach to the soil colloid releasing the smaller cations. The released cations (Mg++, Na+, K+, H+) are solubilized in the soil solution and made available to the plant or removed from the soil profile. As hydrogen is released from the soil colloid into the soil solution, acidity is reduced and pH is raised.

THE CATIONIC EXCHANGE COMPLEX

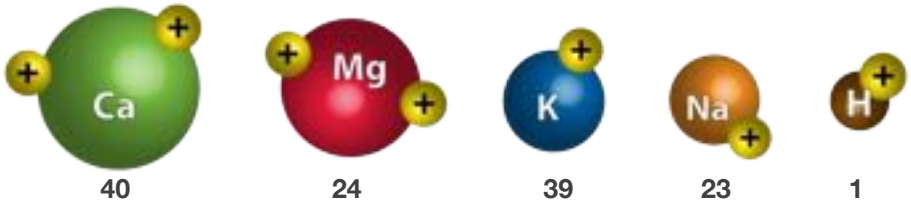
The mixture of Water, Soil, Colloids and Cations



Exchangeable cations are those absorbed on the colloid. Water soluble cations are those ionized in the soil solution. CEC is determined by the number of negative sights on the colloids.

Cation Comparison

Basic Cations



Atomic Weight

The soil colloid has degrees of affinity for various basic cations. This bonding increases with larger atomic weight, ion size and amount of charge.

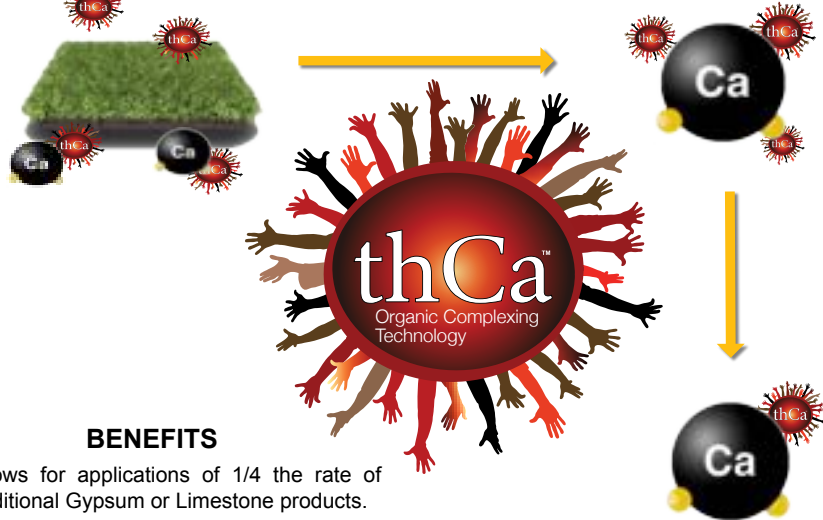
The percentage saturation for each of the cations will usually be within the following ranges for optimum performance:

Calcium (Ca)	65 - 70%
Magnesium (Mg)	10 - 18%
Potassium (K)	3 - 6%
Sodium (Na)	1 - 2%
Hydrogen (H)	10 - 15%

Understanding thCa™

When a **Verde-Cal Product** is applied and put into solution, the **thCa** looks to immediately sequester Calcium in the soil.

Once **thCa** has sequestered a Calcium molecule, it oxidizes the molecule to make it available to the plant or soil solution.



BENEFITS

Allows for applications of 1/4 the rate of traditional Gypsum or Limestone products.

Makes Calcium available NOW, not 2 to 3 years from now.

Goes into the soil sequestering unavailable Calcium making it available to plant and soil solution.

thCa will sequester and oxidize currently unavailable Calcium in the soil.

Calcium remains available longer than other traditional products.

VERDE-CAL®

Enhanced Calclitic Limestone 37% Calcium (Ca)

Use when you need to:

- Raise pH and increase available Calcium

Key product highlights:

- Calcium source - CaCO_3
- Requires 1/4 the rate of standard lime applications
- Reduces hydrogen, sodium, and chlorine in plant and soil
- Contains Aqua-Aid® Penetrant providing uniform movement into entire soil profile

Greens Grade (SGN 90) Coarse Grade (210)
Available in Bags and Bulk Sacks

To maintain optimum pH and growing conditions, apply **VERDE-CAL** at 5 pounds per 1,000 ft² or 220 pounds per acre (250 kg per hectare) at least twice per growing season, or as needed.

Soil test recommendations should be used to determine liming needs.

VERDE-CAL® G

Enhanced Gypsum 22% Calcium (Ca) 19% Sulfur (S)

Use when you need to:

- Increase available Calcium WITHOUT raising pH
- Leach excess Sodium and Magnesium

Key product highlights:

- Calcium source - CaSO_4
- Requires 1/4 the rate of standard gypsum applications
- Supplies plant available Sulfur - SO_4
- Contains Aqua-Aid® Penetrant providing uniform movement into entire soil profile

Greens Grade (SGN 85) Coarse Grade (185)
Available in Bags and Bulk Sacks

For continued optimum growing conditions, apply **VERDE-CAL G** at 5 pounds per 1,000 ft² or 220 pounds per acre (250 kg per hectare) monthly through the growing season, or as needed. Soil test recommendations should be followed.

Refer to label for rates when dealing with specific soil chemistry issues.

VERDE-CAL® K^{PLUS}

Sulfate of Potash with Enhanced Gypsum

Use when you need to:

- Maintain Calcium levels during the growing season 15% Potash (K_2O)
- Leach excess Sodium 7% Calcium (Ca)
- 2% Magnesium (Mg)

Key product highlights:

- Nutrient focus - K_2SO_4 and CaSO_4 14.5% Sulfur (S)
- Excellent source of Potassium, Magnesium, Calcium, Iron and Manganese 4% Iron (Fe)
- 0.25% Manganese (Mn)
- Contains L-Amino Acids 2% L-Amino Acids
- Contains Aqua-Aid® Penetrant providing uniform movement into entire soil profile

Greens Grade (SGN 85)

For continued optimal growing conditions, apply **VERDE-CAL K PLUS** at 5 pounds per 1,000 ft² or 220 pounds per acre (250 kg per hectare) monthly through the growing season. Soil test recommendations should be followed.

Refer to label for additional rates and timing.

VERDE K MAG^{PLUS}

Sulfate of Potash Magnesia with Enhanced Calcium

Use when you need to:

- Maintain Magnesium and Potassium levels during growing season 10% Potash (K_2O)
- Leach excess Sodium 4% Calcium (Ca)
- 5% Magnesium (Mg)

Key product highlights:

- Nutrient focus - Sul-Po-Mag 11% Sulfur (S)
- Excellent source of Potassium, Magnesium, Calcium, Iron and Manganese 2% Iron (Fe)
- 0.5% Manganese (Mn)
- Contains Humic Acid 7% Humic Acid
- Contains Aqua-Aid® Penetrant providing uniform movement into entire soil profile

Greens Grade (SGN 85)

For continued optimal growing conditions, apply **VERDE K MAG PLUS** at 5 pounds per 1,000 ft² or 220 pounds per acre (250 kg per hectare) monthly through the growing season. Soil test recommendations should be followed.

Refer to label for additional rates and timing.

Application Best Practices AcidipHy Products

- Before starting an AcidipHy Products program, obtain a soil, paste extract and water test from a reputable laboratory.
- Do not mix an AcidipHy Product with pesticide or fertilizer unless prior use has shown compatibility.
- AcidipHy-L can be used to buffer your spray tank to desired pH level.
- After making an application of AcidipHy-L or AcidipHy Granular, irrigate to field capacity to flush salts and bicarbonates through the soil profile.
- Continue to monitor water and soil test results and re-apply as needed on a monthly basis.
- If applying AcidipHy Granular in conjunction with Verde-Cal or Verde-Cal G, apply the Verde-Cal or Verde-Cal G first.

Application Best Practices Verde-Cal Products

- Before starting a Verde-Cal Products program, obtain a soil, paste extract and water test from a reputable laboratory.
- Apply product to dry turf if possible. After application, immediately run 2 to 3 rotations of your sprinkler system. Allow product to swell and begin drying. Follow up with another irrigation cycle to completely dissolve material into soil.
- Aerification is a great time to apply Verde-Cal or Verde-Cal G providing a greater impact throughout the soil matrix.
- If applying Verde-Cal or Verde-Cal G in conjunction with AcidipHy Granular, apply the Verde-Cal or Verde-Cal G first.



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