IPM Planning Guide

reference

Soil Reference

GCSAA

Soil Calcium (Ca^{++})

Calcium is the dominant cation in normal soils. As soils become acid, calcium is replaced by hydrogen and aluminum. When soils become alkaline, calcium is replaced by sodium. When sodium increases in the soil, clay particles disperse and hydraulic conductivity becomes restricted. Calcium is a critical plant structural component in cell walls and calcium also acts in signal conduction between the environmental factors and the plant's response.

The role of calcium in IPM

Calcium plays a critical role in management of rapid blight caused by *Labyrinthula terrestris*. Calcium does not directly suppress the disease, but increased calcium levels ensure that sodium does not accumulate to levels above 110 ppm by Mehlich III extraction. Adequate calcium is also known to result in healthy soil and turf conditions that results in suppression of various weed species.

Guidelines

	Low	Normal	Excessive
Mehlich III SLAN	< 750 mg/kg	>750 mg/kg	unknown
Mehlich III BSCR	<60%	60 - 85 %	unknown
Saturated Paste	< 60 mg/l	60 - 200 mg/l	unknown
Saturated Paste %	<20	>20%	unknown

Management

Products that are commonly used to help manage sodium or to supply calcium to deficient soils:

15-0-0 Calcium nitrate

$CaCO_3$ lime

$CaSO_4$*2H2O Magnesium sulfate (Epsom Salt)

$CaCl_2$ Calcium chloride

Soil Magnesium (Mg^{++})

Magnesium is an essential element for plant growth and plays a key role in photosynthesis and other critical pathways in the plant. In recent years, high soil magnesium (>20% of the exchangeable cations) has been found to disperse clay particles in a fashion that is similar to the way high sodium can damage soil structure.

The role of magnesium in IPM

Sufficient and balanced magnesium in the soil are needed to provide the optimum turfgrass performance and weed suppression.

Guidelines

	Low	Normal	Excessive
Mehlich III SLAN	< 140 mg/kg	>140 mg/kg	unknown
Mehlich III BSCR	<12%	12 - 20 %	>20 %
Saturated Paste	< 20 mg/l	20 - 70 mg/l	unknown

Management

Products that are commonly used to increase soil magnesium levels are listed below.

10-0-0 Magnesium nitrate

$CaCO_3$ *$MgCO_3$ dolomitic lime

$MgSO_4$*7H2O Magnesium sulfate (Epsom Salt)

0-0-22 $MgSO_4$*K_2SO_4 magnesium sulfate potassium sulfate (K-mag)

Magnesium sucrate Granusol magnesium

Reducing magnesium can be accomplished by increasing calcium applications followed by leaching rainfall or irrigation. In cases where magnesium is very high, for example serpentine soils, magnesium can not be reduced due to the very high levels of magnesium in this type of clay soil. In this situation, sand topdressing may be the only solution to improve drainage and aeration of the soil.

Mn

Soil Manganese (Mn^{++})

Manganese is an essential element for plant growth and plays a key role in photosynthesis and other critical pathways in the plant. Manganese can substitute for magnesium in some reactions in the plant.

The role of manganese in IPM

Manganese has been found to suppress take-all patch caused by *Gaeumannomyces graminis* on bentgrass. Target levels of manganese are dependent upon soil pH and can be calculated using a manganese availability index value of 110 in the equation below: (use Mehlich III extracted manganese values)

Manganese Availability Index (MnAI) = 101.7 - 15.2 (pH) + 3.75 Mn mg/kg

For optimum turfgrass performance, manganese and iron levels should be balanced at a ratio of 3:1 iron:manganese reported as Mehlich III extracted mg/kg. Although there has been no observed toxicity for manganese levels above the 30 – 45 ppm range reported in the guidelines below, excessive manganese application is not encouraged.

Guidelines

	Low	Normal	Excessive
Mehlich III SLAN	< 30 mg/kg	30 - 45 mg/kg	unknown
MnAI	< 110	> 110	unknown

Management

Manganese products that can be used to adjust soil manganese levels are listed below.

$MnSO_4$*H2O Manganese sulfate

Manganese sucrate Granusol manganese

Soil Nitrogen (N)

Nitrogen is the major growth regulating nutrient used in turfgrass management. Optimum levels are difficult to determine and vary by turfgrass type and turfgrass use. Higher nitrogen rates are applied in high traffic areas and lower nitrogen levels are used for low maintenance sites. Excessive levels can result in environmental contamination.

The role of nitrogen in IPM

The role of nitrogen in IPM varies depending upon the disease that is targeted. Higher levels of nitrogen can aid in suppression of anthracnose caused by *Colletotrichum cereale* on *Poa annua* and dollar spot caused by *Sclerotinia homeocarpa* on bentgrass. Alternatively, high nitrogen levels results in increased susceptibility of ryegrass to brown patch caused by *Rhizoctonia solani*. The guidelines below provide a starting point to begin fine tuning management to suppress the diseases that cause the greatest impact at the site.

Guidelines:

Total plant available nitrogen is the sum of nitrate (NO_3) and ammonium (NH_4) forms of nitrogen.

	Low	Normal	Excessive
Nitrate (NO_3) KCl extracted	< 3 mg/kg	3 - 20 mg/kg	> 20 mg/kg
Ammonium (NH_4) KCl extracted	Unknown	0 – 7 mg/kg	> 10 mg/kg
Total (NO_3 + NH_4)	< 3mg/kg	3 – 20 mg/l	> 20 mg/kg

Management

There are a multitude of nitrogen products available for use in managing soil nitrogen levels. Here are a few quick and slow release options:

<u>Quick release</u>

- 15-0-0 Calcium nitrate
- 13-0-44 Potassium nitrate
- 46-0-0 Urea
- 21-0-0 Ammonium sulfate

<u>Slow release</u>

IBDU Isobutylenediurea
Ureaformaldehyde
Sulfur coated urea
Polymer coated urea

Soil Phosphorus (P)

Phosphorus requirements may vary greatly depending upon soil conditions and turf management goals. Excess phosphorus can result in contamination of surface and ground water. To prevent over-application and leaching of phosphorus, a phosphorus saturation index (PSI) is calculated (see below) to determine if maximum levels of soil phosphorus have been reached or exceeded. Phosphorus applications should be avoided when the PSI reaches 0.23.

$$\textbf{Phosphorus Saturation Index (PSI)} = \frac{\frac{\text{P mg/kg}}{31}}{\left(\frac{\text{Fe mg/kg}}{56} + \frac{\text{Al mg/kg}}{27}\right)}$$

(NOTE: Phosphorus and aluminum are Mehlich III extracted)

The minimum desired soil phosphorus level will depend upon turf performance and desire to suppress Poa annua.

The role of phosphorus in IPM

The role of phosphorous in control of insects and diseases is not well defined. However, there are some reports that low phosphorus can favor bentgrass in a poa-bentgrass golf course green. The levels below have been targeted toward healthy bentgrass growth and are dependent upon soil pH and extraction methods. .

Guidelines

	Low	Normal	Excessive
Bray II P	< 50 mg/kg	>50 mg/kg	Refer to PSI
Mehlich III P	< 50	>50 mg/kg	Refer to PSI
Olsen P (soil pH > 7.5)	< 5 mg/kg	>15 mg/kg	Refer to PSI
PSI	——	<0.23	>0.23

Management

If the phosphorus saturation index (PSI) exceeds 0.23, avoid further application of phosphorus and increase soil iron levels.

Phosphorus products that are used to address deficiencies include:

- 11-52-0 Monoammoniumphosphate
- 18-56-0 Diamonnium phosphate
- 0-52-34 Monopotassium phosphate
- 0-45-0 Triple super phosphate

Soil Potassium (K^+)

Potassium is an essential element for plant growth and development. It plays a major role in regulation of plant water relations and it is transported freely throughout the plant.

The role of potassium in IPM

The role of potassium in IPM is controversial. Research indicates that increased potassium can suppress rapid blight caused by *Labyrinthula terrestris* while other studies suggest that the snow molds might be increased in high potassium environments. Moderation seems to be the key in this situation and a target of about 110 mg/kg is a good starting place.

Guidelines

	Low	Normal	Excessive
Mehlich III SLAN	< 110 mg/kg	>110 mg/kg	>300 mg/kg
Mehlich III BSCR	< 2 %	2 - 7%	unknown
Saturated Paste	< 40 mg/l	40 - 100mg/l	unknown

Management

Soil potassium levels can be increased by use of one of the products listed below. Use caution because each product carries a potentially detrimental companion anion (negatively charged molecue such as nitrate sulfate, phosphate, chloride). Leaching irrigation or rainfall will easily remove excessive potassium.

13-0-44 Potassium nitrate

0-0-50 K_2SO_4 Potassium sulfate

0-0-60 KCl Potassium chloride

0-0-22 $MgSO_4$*K_2SO_4 magnesium sulfate - potassium sulfate (K-mag)

0-52-34 KH2PO5 mono potassium phosphate

Soil Sodium (Na^+)

Sodium is present in the earth's crust at about the same concentration as potassium but most turfgrass plants have developed high selectivity for uptake of potassium. Sodium has been found to be an essential nutrient for a few plant species but in practical terms, sodium plays a detrimental role in turfgrass and soil management. For that reason, the target levels of sodium are low and management of sodium focuses primarily on supplying calcium to displace sodium.

The role of sodium in IPM

Sodium plays a direct role in turfgrass susceptibility to rapid blight caused by *Labyrinthula terrestris*. Increased sodium results in increased susceptibility to rapid blight. In addition high salinity and sodium stress have been implicated in increasing susceptibility to senectotrophic pathogens that include anthracnose (*Colletotrichum cerealis*) and the leaf spots and melting out caused by *Bipolaris* spp. and *Curvularia* spp. In addition, low sodium soils benefit general plant health and aid in preventing weed invasion and recovery from damage caused by insects.

Guidelines

	Low	Normal	Excessive
Mehlich III SLAN	unknown	<110 mg/kg	> 110mg/kg
Mehlich III BSCR	unknown	<3 %	>6 %
Saturated Paste	unknown	0 – 30 mg/l	> 30 mg/l
Saturated Paste %	unknown	0 – 30%	> 35%

Management

Application of the calcium products will help to manage and reduce soil sodium levels.

15-0-0 Calcium nitrate

$CaCO_3$ lime

$CaSO_4$*2H2O Magnesium sulfate (Epsom Salt)

$CaCl_2$ Calcium chloride

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Soil Salinity Reference

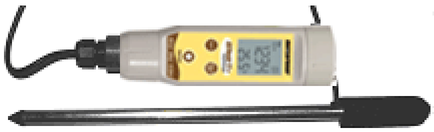
Presented by the

Environmental Institute for Golf

The philanthropic organization of GCSAA

Monitoring soil salinity

Field Scout EC probe and meter



Protocol for in-office EC measurements (most accurate method):

1) Obtain a representative soil sample, about 50cc (about 2 oz) in a small cup.
2) Add your irrigation water while stirring until the soil surface glistens. Don't add too much water. If the water can be poured off, you've added too much and you will need to start over or add dry soil.
3) Stick the probe into the soil so the electrodes are completely immersed in the soil.
4) Read the meter and convert the meter reading using Table 1 below. Record the converted value for future reference.

Protocol for in-field EC measurements:

1) Saturate the area of the green to be evaluated with irrigation water. The soil must be saturated to obtain an accurate reading.
2) Stick the probe into the soil so the electrodes are completely immersed in the soil.
3) Read the meter and convert the meter reading using Table 1 below. Record the converted value for future reference.

Measurements taken directly from soils in the field are more variable because they are dependent upon soil moisture conditions. However, the direct field readings will provide a quick and easy estimate of soil solution EC which will allow you to determine when salts are building up and leaching is needed. For example, when the meter reading exceeds 0.7 mS/cm (dS/m) for soil under annual bluegrass turf, the extract EC is approaching 3.0 dS/m, the upper limit for healthy poa growth and development (Table 2). In this example, leaching will be needed to prevent further increase in EC and resultant plant stress.

Calibration: The meter should be calibrated once per week or before use if the meter has stored for more than a week. To calibrate, pour a small volume of the calibration solution listed below into a small container. Submerge the meter electrodes completely into the calibration solution. Adjust the meter reading according to manufacturer's instructions, until the meter reads 2.76 mS/cm.

Supplies:

- Field Scout soil EC probe and meter (catalogue # 2265FS) from Spectrum Technologies, 800-248-8873 or www.specmeters.com. About $350.
- Calibration solution 2.76 mS/cm (catalogue # 2254 from Spectrum Technologies, , 800-248-8873 or www.specmeters.com). About $13.00

Table 1. Conversion table for determining the saturated soil extract EC (Extract EC) from the direct soil reading with your salinity meter (Meter). All values are in mS/cm =dS/m= mmhos/cm. To convert your meter reading to the correct EC reading, use the following equation:

EC (mS/cm) = (meter reading X 2.7) + 0.8

Meter	Extract EC	Meter	Extract EC	Meter	Extract EC
0.1	1.1	1.1	3.8	2.1	6.5
0.2	1.3	1.2	4.0	2.2	6.7
0.3	1.6	1.3	4.3	2.3	7.0
0.4	1.9	1.4	4.6	2.4	7.3
0.5	2.2	1.5	4.9	2.5	7.6
0.6	2.4	1.6	5.1	2.6	7.8
0.7	2.7	1.7	5.4	2.7	8.1
0.8	3.0	1.8	5.7	2.8	8.4
0.9	3.2	1.9	5.9	2.9	8.6
1.0	3.5	2.0	6.2	3.0	8.9

Table 2. Relative tolerance of turfgrasses to soil salinity (Harivandi et. al. 1992).

Sensitive < 3 mS/cm	Moderately Sensitive 3-6 mS/cm	Moderately Tolerant 6-10 mS/cm	Tolerant > 10 mS/cm
Annual bluegrass	Annual ryegrass	Bent. cv. Seaside	Alkaligrass
Colonial bentgrass	Chewings fescue	Perennial ryegrass	Bermudagrass
Kentucky bluegrass	Creeping bentgrass	Tall fescue	Seashore paspalum
Rough bluegrass	Hard fescue	Buffalograss	St. Augustinegrass
Centipedegrass	Bahiagrass	Zoysiagrass	

Reference:

Harivandi, M.A., Butler, J.D. and Wu, L. 1992. Salinity and turfgrass culture. Pages 207-229 in Turfgrass (Waddington, D.V., Carrow, R.N. and Shearman, R.C. eds) Series No. 32. American Society of Agronomy, Madison, WI.

SOIL REFERENCE

Weekly Electrical Conductivity Weekly Record Sheet

Year: ____________ Meter used: ____________________________________

	Location (e.g., G18, F1, R3)													
	Meter	ECe	Meter	ECe	Meter	ECe	Meter	ECe	Meter	ECe	Meter	ECe	Meter	ECe
Jan 1														
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To convert meter readings to ECe values in dS/m, see reverse side of sheet