Science Series Part 2:

**Get in "The Zone" – A Simple Approach to Soil Test Analysis**

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## Soil Test & Saturated Paste Analysis Test Case Study Examples

Understanding each element's role in the turfgrass system is crucial for interpreting a soil analysis. By knowing how these elements are quantified in various tests and focusing on a few key values, you should be able to interpret a soil test and paste extract in just a few minutes to determine what actions, if any, can improve nutrient efficiency, thus enhancing performance conditions at your golf course.

The following three test result examples are paired with recommended solutions to address the identified issues

**EXAMPLE #1**

### Ontario Soil Test Example
### Green 2G

Target
K 5% Mg 12% Ca 68% H 10% Na <2%

CHEMICAL EXTRACTION SOIL RESULTS

Report Date: Printed Date:Oct 28, 2022

| Sample Number | Lab Number | Organic Matter | Phosphorus - P ppm Bicarb | Phosphorus - P ppm Bray-P1 | Potassium K ppm | Magnesium Mg ppm | Calcium Ca ppm | Sodium Na ppm | pH | Buffer | CEC meq/100g | Percent Base Saturations % K | % Mg | % Ca | % H | % Na |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2G | 08770 | 0.7 | 11 M | 18 M | 8 VL | 136 VL | 7200 VH | 27 VL | 7.7 | | 37.3 | 0.1 | 3.0 | 96.6 | | 0.3 |
| 10T | 08771 | 3.3 | 20 L | 28 L | 59 L | 126 M | 1710 VH | 66 VH | 7.3 | | 10.0 | 1.5 | 10.5 | 85.3 | | 2.9 |
| 9G | 08772 | 0.8 | 12 M | 17 M | 12 VL | 150 VL | 7200 VH | 32 L | 7.8 | | 37.4 | 0.1 | 3.3 | 96.2 | | 0.4 |
| 18F | 08773 | 4.2 | 15 L | 21 VL | 75 M | 145 L | 1960 H | 93 VH | 7.2 | | 12.2 | 1.6 | 9.9 | 80.5 | 4.6 | 3.3 |

| Sample Number | Sulfur S ppm | Zinc Zn ppm | Manganese Mn ppm | Iron Fe ppm | Copper Cu ppm | Boron B ppm | Soluble Salts ms/cm | Saturation %P | Aluminum Al ppm | Saturation %Al | Nitrate Nitrogen NO3-N ppm | K/Mg Ratio | ENR | Field ID |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2G | 6 VL | 6.5 H | 20 M | 42 H | 0.6 M | 0.1 VL | | 1 VL | 23 | 0.0 G | 1 VL | 0.03 | 19 | |
| 10T | 18 L | 5.0 H | 53 VH | 73 VH | 2.2 H | 0.5 L | | 2 VL | 358 | 0.0 G | 1 VL | 0.14 | 45 | |
| 9G | 6 VL | 6.9 H | 22 M | 40 H | 0.6 M | 0.1 VL | | 1 VL | 18 | 0.0 G | 1 VL | 0.03 | 20 | |
| 18F | 21 L | 4.0 M | 73 VH | 74 VH | 2.8 H | 0.5 L | | 2 VL | 454 | 0.1 G | 1 VL | 0.16 | 54 | |

OE VL = VERY LOW, L = LOW, M = MEDIUM, H = HIGH, VH = VERY HIGH, G = GOOD, MA = MARGINAL, MT = MODERATE PHYTO-TOXIC, T = PHYTO-TOXIC, ST = SEVERE PHYTO-TOXIC

SOIL FERTILITY GUIDELINES (lbs/ac)

| Sample Number | Crop | Yield Goal | Lime Tons/Acre | N | P2O5 | K2O | Mg | Ca | S | Zn | Mn | Fe | Cu | B |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|

Is soil silica based or calcium based? Calcareous
Is Sodium OK? Sodium < 2% OK
Is Calcium OK? Calcium > 68% high (calcareous)
Is Potassium OK? Potassium < 5%, low BUT
Is Magnesium OK? Magnesium < 12%, low BUT

Need more potassium in the soil

Reported Date:2022-11-09
Printed Date:Nov 9, 2022

**Saturated Paste Analysis**



Ontario Soil Test Example

PASTE EXTRACTION SOIL RESULTS Green 2G

| Sample Number | Lab Number | Organic Matter | pH | Buffer | Phosphorus P ppm | Potassium K ppm | Magnesium Mg ppm | Calcium Ca ppm | Sulfur S ppm | Sodium Na ppm | Soluble Salts mmhos/cm | Nitrate Nitrogen NO3-N ppm | Chloride Cl ppm |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2G | 12489 | | 7.8 | | 2.244 | 4 | 4 | 12 | 2 | 13 | 0.14 | 3 | 7 |
| 10T | 12490 | | 7.5 | | 2.91 | 9 | 6 | 39 | 11 | 22 | 0.3 | 3 | 30 |
| 9G | 12491 | | 7.9 | | 1.883 | 4 | 3 | 13 | 2 | 11 | 0.12 | 3 | 7 |
| 18F | 12492 | | 7.5 | | 2.411 | 9 | 7 | 41 | 10 | 30 | 0.33 | 3 | 41 |
| Optimum Range | | | | | 7-12 | 30-40 | 20-25 | 125-200 | 12-15 | 4-10 | | | |

| Sample Number | Lab Number | Zinc Zn ppm | Manganese Mn ppm | Iron Fe ppm | Copper Cu ppm | Boron B ppm | NO3-N ppm | Percent Base Saturations % K | % Mg | % Ca | % Na | %Cl | %NO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2G | 12489 | | 1 | 1 | 0.029 | 0.022 | 3 | 5.2 | 22.7 | 34 | 38.4 | 7.1 | 3.1 |
| 10T | 12490 | | 1 | 2 | 0.047 | 0.011 | 3 | 6 | 13.9 | 49.9 | 30.4 | 17.1 | 1.4 |
| 9G | 12491 | 0.026 | 1 | 1 | 0.017 | 0.023 | 3 | 6.1 | 19.9 | 39.7 | 34.5 | 8.3 | 3.6 |
| 18F | 12492 | 0.02 | 1 | 2 | 0.044 | 0.015 | 3 | 5.9 | 14.5 | 43.4 | 36.4 | 17.7 | 1.3 |
| Optimum Range | | | | | | | | 11-13 | 8-15 | 55-75 | <10 | <10 | 8-10 |

2G

1. **Wilt Susceptibility**
   - K% > Na%
   - 5.2 < 38.4

   Turf susceptible to wilt

2. **Ca% : Mg% + K% Ratio**

   Ca > Mg + K

   34 Ca > 22.7 Mg + 5.2 K

   Ca: Mg& K Ratio GOOD

- Need potassium
- Increase solubility with acids

3. **Enough Total Soluble Ca?**

   **Ca > 40 ppm**

   Ca = 12 ppm

   Need more soluble Ca. Solubilize with acids

Summary for Green 2G

This calcareous soil is adequate, but it tends to wilt during the growing season due to the high sodium-to-potassium ratio in the saturated paste test. The low available calcium (12 ppm) results in a softer playing surface because of the elevated soluble sodium.

Action

1. Increasing soluble calcium by applying a long-lasting acid will help displace sodium and firm the surface.

2. Adding potassium before heat or traffic stress will minimize sodium-induced wilt.

**EXAMPLE #2**

## Soil Report

Job Name: **Alberta Example** Date: 9/26/2022

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Sample Location | | | Green | Green | Green | | |
| Sample ID | | | 7 | 10 | 13 | | |
| Lab Number | | | 36 | 37 | 38 | | |
| Sample Depth in Inches | | | 8 | 8 | 8 | | |
| Total Exchange Capacity (M. E.) | | | 11.75 | 15.29 | 14.63 | | |
| pH of Soil Sample | | | 8.7 | 8.6 | 8.6 | | |
| Organic Matter, Percent | | | 0.29 | 0.58 | 0.65 | | |
| ANIONS | SULFUR: | p.p.m. | 13 | 12 | 14 | | |
| | Mehlich III Phosphorous: | ppm | 17 | 17 | 22 | | |
| EXCHANGEABLE CATIONS | CALCIUM: ppm | Desired Value<br>Value Found<br>Deficit | 1597<br>2004 | 2079<br>2628 | 1989<br>2528 | | |
| | MAGNESIUM: ppm | Desired Value<br>Value Found<br>Deficit | 169<br>143<br>-26 | 220<br>173<br>-47 | 210<br>156<br>-54 | | |
| | POTASSIUM: ppm | Desired Value<br>Value Found<br>Deficit | 183<br>44<br>-139 | 238<br>68<br>-170 | 228<br>71<br>-157 | | |
| | SODIUM: | ppm | 24 | 24 | 21 | | |
| BASE SATURATION % | Calcium (60 to 70%) | | 85.30 | 85.94 | 86.43 | | |
| | Magnesium (10 to 20%) | | 10.16 | 9.42 | 8.89 | | |
| | Potassium (2 to 5%) | | 0.96 | 1.14 | 1.25 | | |
| | Sodium (.5 to 3%) | | 0.89 | 0.69 | 0.64 | | |
| | Other Bases (Variable) | | 2.70 | 2.80 | 2.80 | | |
| | Exchangable Hydrogen (10 to 15%) | | 0.00 | 0.00 | 0.00 | | |
| TRACE ELEMENTS | Boron (p.p.m.) | | 0.71 | 0.46 | 0.54 | | |
| | Iron (p.p.m.) | | 110 | 127 | 130 | | |
| | Manganese (p.p.m.) | | 53 | 54 | 53 | | |
| | Copper (p.p.m.) | | < 0.2 | 0.25 | 0.23 | | |
| | Zinc (p.p.m.) | | 0.63 | 0.87 | 0.78 | | |
| | Aluminum (p.p.m.) | | 38 | 45 | 46 | | |
| OTHER | Ammonium (p.p.m.) | | 0.5 | 0.4 | 0.5 | | |
| | Nitrate (p.p.m.) | | 1 | 1.5 | 1.4 | | |
| | | | | | | | |
| | | | | | | | |

Green 13

Is soil silica based or calcium based?

Is Sodium OK?

Is Calcium OK?

Is Potassium OK?

Is Magnesium OK?

Calcareous (CEC 14.63) pH 8.6

Sodium < 2% OK ( actual 0.64)

Calcium > 68% high (calcareous) OK actual 86.43

Potassium < 5%, low BUT Should be at least 1.28-Need potassium

Magnesium < 8.89%, Add a little

Note ammonium ppm vs nitrate ppm

Take soil profile

## Saturated Paste Report

Job Name: **Alberta Example** Date: 9/26/2022

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Sample Location | | | Green | Green | Green | | |
| Sample ID | | | 7 | 10 | 13 | | |
| Lab Number | | | 187086 | 187087 | 187088 | | |
| Water Used | | | DI | DI | DI | | |
| pH | | | 8.7 | 8.6 | 8.6 | | |
| Soluble Salts | | ppm | 60 | 52 | 58 | | |
| Chloride (Cl) | | ppm | 11 | 8 | 7 | | |
| Bicarbonate (HCO3) | | ppm | 44 | 34 | 31 | | |
| ANIONS | SULFUR | ppm | 2.19 | 2 | 2.65 | | |
| | PHOSPHORUS | ppm | 0.83 | 0.68 | 0.7 | | |
| SOLUBLE CATIONS | CALCIUM | ppm | 7.54 | 6.85 | 7.72 | | |
| | | meq/l | 0.38 | 0.34 | 0.39 | | |
| | MAGNESIUM | ppm | 3.53 | 2.88 | 3.17 | | |
| | | meq/l | 0.29 | 0.24 | 0.26 | | |
| | POTASSIUM: | ppm | 3.81 | 4.12 | 4.16 | | |
| | | meq/l | 0.10 | 0.11 | 0.11 | | |
| | SODIUM | ppm | 3.88 | 3.07 | 3.32 | | |
| | | meq/l | 0.17 | 0.13 | 0.14 | | |
| PERCENT | Calcium | | 40.18 | 41.63 | 42.80 | | |
| | Magnesium | | 31.31 | 29.14 | 29.24 | | |
| | Potassium | | 10.55 | 13.01 | 11.98 | | |
| | Sodium | | 17.96 | 16.22 | 15.98 | | |
| TRACE ELEMENTS | Boron (p.p.m.) | | 0.05 | 0.04 | 0.03 | | |
| | Iron (p.p.m.) | | 3.09 | 2.51 | 3.12 | | |
| | Manganese (p.p.m.) | | 0.08 | 0.05 | 0.06 | | |
| | Copper (p.p.m.) | | < 0.02 | < 0.02 | < 0.02 | | |
| | Zinc (p.p.m.) | | < 0.02 | < 0.02 | < 0.02 | | |
| | Aluminum (p.p.m.) | | 0.52 | 0.57 | 0.74 | | |
| OTHER | | | | | | | |

**GREEN 13**

**1. Wilt Susceptibility**

- K% > Na%
- 11.98 < 15.98

Turf susceptible to wilt

**2. Ca% : Mg% + K% Ratio**

Ca > Mg + K

42.8% Ca > 29.24 Mg + 11.98 K

Ca: Mg& K Ratio OK

**3. Enough Total Soluble Ca?**

**Ca > 40 ppm**

Ca = 7.72 ppm

Need more soluble Ca.

Solubilize with acids

Summary for Green 13

This calcareous soil is adequate but slightly prone to wilting during the growing season due to the high sodium-to-potassium ratio from the saturated paste test. The low available calcium (7.72 ppm) will create a softer playing surface because of the increased soluble sodium.

Action

1. Increasing the soluble calcium with long-lasting acid will help displace and sink the sodium, thereby firming the surface.

2. Adding potassium before heat or traffic stress will minimize sodium-induced wilt.

**EXAMPLE #3**

## Soil Report

Job Name: **British Columbia Example 3** Date: 9/24/2018

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| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | Sample Location | | Greenn | Green | | Optimum | |
| | Sample ID | | 3 | 12 | | | |
| | Lab Number | | 28 | 29 | | | |
| | Sample Depth in inches | | 5 | 5 | | | |
| | Total Exchange Capacity (M. E.) | | 6.33 | 5.75 | | | |
| | pH of Soil Sample | | 8.4 | 8.0 | | 6.5 | |
| | Organic Matter, Percent | | 1.05 | 1.56 | | 2.25 | |
| ANIONS | SULFUR: | p.p.m. | 142 | 114 | | 11 | |
| ANIONS | Mehlich III Phosphorous: | ppm | 29 | 19 | | | |
| EXCHANGEABLE CATIONS | CALCIUM: ppm | Desired Value<br>Value Found<br>Deficit | 860<br>755<br>-105 | 781<br>628<br>-153 | | *Low - add 306lbs/acre/ year or 7lbs/ 1000/year | |
| EXCHANGEABLE CATIONS | MAGNESIUM: ppm | Desired Value<br>Value Found<br>Deficit | 99<br>156 | 99<br>168 | | | |
| EXCHANGEABLE CATIONS | POTASSIUM: ppm | Desired Value<br>Value Found<br>Deficit | 99<br>133 | 99<br>109 | | | |
| EXCHANGEABLE CATIONS | SODIUM: | ppm | [illegible] | 168 | | 20 - 25 | |
| BASE SATURATION % | Calcium (60 to 70%) | | 59.63 | 54.66 | | ~Low | |
| BASE SATURATION % | Magnesium (10 to 20%) | | 20.62 | 24.45 | | ~High | |
| BASE SATURATION % | Potassium (2 to 5%) | | 5.40 | 4.85 | | Ok | |
| BASE SATURATION % | Sodium (.5 to 3%) | | 11.41 | 12.69 | | *High | |
| BASE SATURATION % | Other Bases (Variable) | | 3.00 | 3.40 | | | |
| BASE SATURATION % | Exchangable Hydrogen (10 to 15%) | | 0.00 | 0.00 | | | |
| TRACE ELEMENTS | Boron (p.p.m.) | | 0.42 | 0.59 | | 1.2 | |
| TRACE ELEMENTS | Iron (p.p.m.) | | 223 | 171 | | 100 - 150 | |
| TRACE ELEMENTS | Manganese (p.p.m.) | | 34 | 37 | | 25 - 40 | |
| TRACE ELEMENTS | Copper (p.p.m.) | | 1.33 | 1.97 | | 10 - 15 | |
| TRACE ELEMENTS | Zinc (p.p.m.) | | 2.24 | 2.84 | | 10 - 20 | |
| TRACE ELEMENTS | Aluminum (p.p.m.) | | 155 | 148 | | | |
| OTHER | Ammonium (p.p.m.) | | 0.3 | 0.5 | | | |
| OTHER | Nitrate (p.p.m.) | | 1 | 1.2 | | | |

Green 3

(CEC 6.33)
Sodium < 2% high actual 11.41
Calcium > 68% actual 59.63
Potassium > 5%, good 5.40
Potassium to Na ratio ? Check Saturated Paste
Magnesium - 12%, High @ 20.62

Needs calcium sulfate (gypsum)

## Saturated Paste Report

Job Name: British Columbia Example 3 — Date: 9/24/2018

| | | | Greenn | Green | | Optimum | |
|---|---|---|---|---|---|---|---|
| Sample Location | | | | | | | |
| Sample ID | | | 3 | 12 | | | |
| Lab Number | | | 123451 | 123452 | | | |
| Water Used | | | DI | DI | | | |
| pH | | | 8.4 | 8.0 | | 6.5 | *High |
| Soluble Salts | | ppm | 367 | 285 | | < 960 | |
| Chloride (Cl) | | ppm | 44 | 33 | | < 50 | |
| Bicarbonate (HCO3) | | ppm | 112 | 127 | | < 50 | * High |
| ANIONS | SULFUR | ppm | 40 | 27.05 | | 5 - 10 | *High |
| | PHOSPHORUS | ppm | 0.84 | 0.69 | | 1 - 3 | ~Low |
| SOLUBLE CATIONS | CALCIUM | ppm | 37.31 | 26.94 | | 40 - 60 | * Low |
| | | meq/l | 1.87 | 1.35 | | | |
| | MAGNESIUM | ppm | 12.43 | 9.70 | | 8 - 12 | |
| | | meq/l | 1.04 | 0.81 | | | |
| | POTASSIUM: | ppm | 16.06 | 11.20 | | 15 - 20 | |
| | | meq/l | 0.42 | 0.29 | | | |
| | SODIUM | ppm | 55.53 | 46.03 | | < 20 | * High |
| | | meq/l | 2.41 | 2.00 | | | |
| PERCENT | Calcium | | 32.54 | 30.29 | | 55 - 60 | *Low |
| | Magnesium | | 18.07 | 18.17 | | 18 - 20 | Ok |
| | Potassium | | 7.28 | 6.54 | | 9 - 10 | ~Low |
| | Sodium | | 42.11 | 45.00 | | < 8 | *High |
| TRACE ELEMENTS | Boron (p.p.m.) | | 0.02 | 0.02 | | 0.1 | |
| | Iron (p.p.m.) | | 1.8 | 1.16 | | 0.3 | |
| | Manganese (p.p.m.) | | 0.09 | 0.09 | | 0.1 | |
| | Copper (p.p.m.) | | 0.02 | 0.03 | | 0.08 | |
| | Zinc (p.p.m.) | | 0.02 | 0.02 | | 0.08 | |
| | Aluminum (p.p.m.) | | 2.13 | 1.34 | | | |
| OTHER | | | | | | | |

GREEN 3

**1. Wilt Susceptibility**

- K% > Na%
- 7.28 < 42.11

Prone to wilt. Decrease sodium

**2. Ca% : Mg% + K% Ratio**

Ca > Mg + K

32.54% Ca > 18.07 Mg + 7.28 K

Ca: Mg & K ratio good

**3. Enough Total Soluble Ca?**

**Ca > 40 ppm**

Ca = 37.31 ppm

Need more soluble Ca.

Solubilize with acids

<u>Summary for Green 3</u>

Sodium is very high at 11.41%. What is causing this? According to the chemical extraction test, calcium is low at 59.63%. However, another factor contributes to the elevated sodium levels.

The saturated paste test shows that soluble calcium is slightly low at 37.31 ppm, while the soluble sodium ppm exceeds that of calcium. Additionally, the bicarbonates are at 112 ppm, which is high since they should be around 50 ppm in the saturated paste test.

<u>Action</u>

1. Perform an irrigation water test to determine the source of the sodium and whether it contributes to the high bicarbonate level.

2. Regardless, the strategy to reduce sodium is to utilize calcium sulfate. The calcium will displace the sodium, while the sulfate will combine with the sodium, creating sodium sulfate, allowing the sodium to sink through the soil. Spray long-lasting acid surfactants to solubilize more calcium and displace the sodium. 3. Adding potassium before heat or traffic stress will minimize sodium-induced wilt.