TORV

Sustainable Agronomics

November 20, 2021

Company
Address Line 1
Address Line 2
City, State, Zip

Cover Letter

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Executive Summary

Green

- All calculations are based on 3.75 lb of N/ft^2 annually applied.
- No additional elements are required as fertilizer.

Organic Matter

- The average 440°C in the spring of 2021 was 8.67%.
- The average 440°C in the fall of 2021 was 8.44%
- This represents a decrease in OM% of .23% or -6.8 grams per kg of soil.
- Given the current rate of decrease (6.8 g/kg) and if it remains constant, in 2022 applying 1.4 mm (.05 inches) of sand should reduce the OM% to a relative average of 7% in the top 2 cm.
- Given the current rate of decrease (6.8 g/kg) and if it remains constant, in 2022 applying 3.4 mm (.13 inches) of sand should reduce the OM% to a relative average of 6% in the top 2 cm.

Water

- The bicarbonates pose a medium risk for soil problems.
- As discussed, the sample differences between the irrigation and the storage pond were minimal. This was not the case in the spring or fall of 2020. The theory is that outgoing and incoming water is currently balanced and therefore does not allow for the build-ups in excess salts.
- Overall water quality at the time of sampling poses little risk for soil problems.

How to interpret these results

The Minimum Levels for Sustainable Nutrition (MLSN) guidelines are applied in this report. These guidelines are developed and based on two key principles (Global Soil Survey):

- Excellent turf conditions can be produced when essential nutrients are present in the soil at or above the MLSN guideline. As long as the element of interest remains above the MLSN guideline, adding more of that element is not expected to confer an improvement to turfgrass performance.

- The amount of nitrogen supplied to the grass controls the growth rate and consequently the uptake of mineral nutrients by the grass.

How and why MLSN works

It works by ensuring the grass is supplied with all the nutrients it can use while keeping a safe amount of each nutrient untouched in the soil as a reserve. The MLSN calculation identifies the amount of nutrients the grass uses at a particular site. It then ensures the grass is either supplied with 100% of those nutrients from fertilizer, from soil, or from a combination of soil and fertilizer (Woods et al., 2014).

This approach recognizes that grass uses nutrients. Rather than trying to maintain all the nutrients the grass could ever use, and then some, in a hypothetical optimum soil that doesn't exist, the MLSN approach makes a careful estimate of plant use and makes sure the grass is supplied with that much while still keeping a safe amount in reserve, untouched, in the soil. This approach puts the turfgrass manager in control.

"The fundamental principle of successful greenkeeping is the recognition of the fact that the finest golfing grasses flourish on poor soil and that more harm is done by over-, rather than underfertilizing" (MacKenzie, 1998).

Why MLSN is needed

Conventional soil test interpretation is based on guidelines that are higher than required to produce high quality turf. Turner and Waddington (1978) described this problem 40 years ago:

"Unfortunately, turfgrass recommendations appear to be based on research done with other crops, such as forages, results from turfgrass fertility studies not designed to relate to soil testing, and the best judgement of the agronomist making the recommendations."

Carrow et al. (2001, p. 164) wrote about this problem in their Turfgrass Soil Fertility book:

"In some cases, turfgrasses have been placed in a 'high' P and K requirement category, while pasture grasses were in a 'low' category. This decision was based on economics, not agronomics. The cost of fertilization was not considered of primary importance for turf."

The MLSN approach to soil test interpretation is designed to make a fertilizer recommendation that is based on supplying the grass all the nutrients that it can use, while ensuring a safe amount remains in the soil. This solves – or more precisely, avoids – many of the problems of conventional soil test interpretation

The following "Frequently asked questions" is directly from Dr. Micah Woods's "MLSN Cheat Sheet", February 1, 2018.

Frequently asked questions

How do I know the nutrients are available?

You know the nutrients are available because you've done a soil test. That's what a soil test is – by definition it produces a nutrient availability index. If you don't trust the soil tests, then I suggest skipping them altogether. Instead, assume the soil can supply nothing, and supply to the grass 100% (or a little more) of its possible use of each element. This isn't the most efficient way to do it, but you won't need to worry about availability, and it is guaranteed to supply all that the grass can use.

MLSN guideline, target level or minimum level?

Conventional soil test interpretation may give the impression that there are target or optimum levels in the soil. The MLSN guideline is a minimum value – minimum is the M in MLSN so we haven't always repeated that – that one doesn't want to drop below. It's not a level below which one will have deficiency. It's not a target level that one ideally will have the soil at. What the MLSN guideline represents is a level in the soil with enough of that element to produce high quality turf. There is high quality turf in soils with less of that element too, and that's why we are confident the MLSN guideline is a safe level. But there aren't a lot of soils with less, so we suggest keeping the soil from dropping below the MLSN guideline.

Seriously, the same minimum for every grass, soil, and location? No regional customization?

We are confident that the MLSN guideline is enough to produce high quality turf for every grass, everywhere. MLSN has the ultimate customization, however, because the grass use of elements is entirely site specific. In order to ensure the soil doesn't drop below the MLSN guideline, one has to estimate the expected nutrient use by the plant over time. That's where the customization comes in.

How is this different than conventional soil test interpretation?

The focus of MLSN is on keeping the soil from dropping below a known safe level. To do this, one must account for how much the grass uses over time. The MLSN approach explicitly calculates the grass use. The conventional interpretation (Carrow et al., 2004) is about classifying based on soil levels.

What about micronutrients?

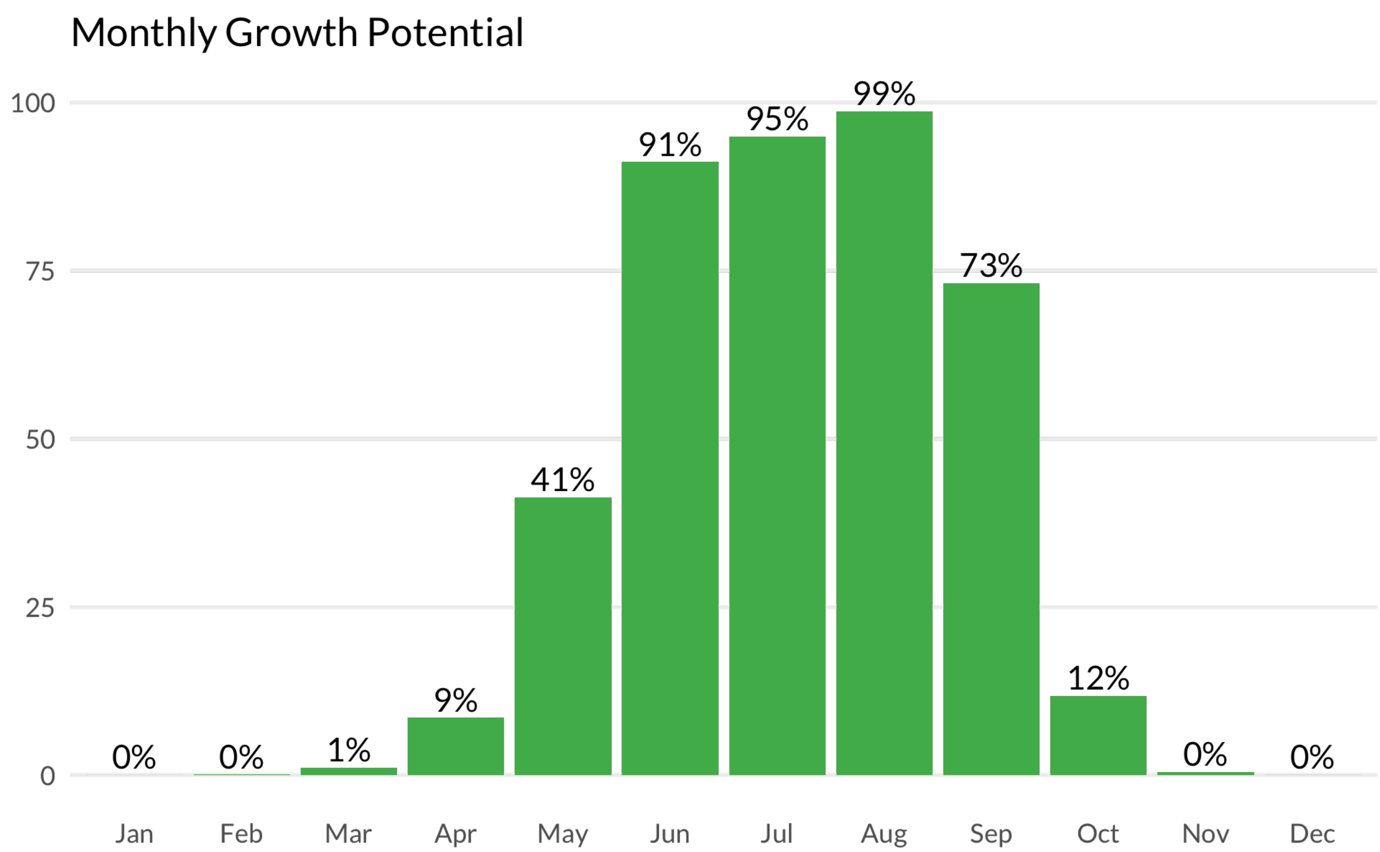
I don’t worry about them. They are used in tiny amounts by the grass. The grass uses about 400 times as much N as it does the most used micronutrient. The grass probably can get all the micronutrients it needs from the soil, because it uses such small quantities of them. And because it uses such small quantities of them, if you are worried about it, apply micronutrients. It doesn’t cost much and is easy to do.

What about salinity?

Salinity can kill the grass. That’s a major problem. To keep the grass from getting killed by high salinity, one needs to leach the salts from the soil. I wouldn’t worry much about soil nutrient levels or MLSN if I have a salinity problem. I would leach the salts, and I would supply 100% or a little more than the grass can use.

Turf Growth Potential Model

The temperature data is provided by NOAA using 30-year climate normals and is site-specific to your location. Pace Turf, LLC (Gelernter and Stowell, 2005) developed the growth potential model to explain the myriad of ways in which weather impacts turf growth. The model considers turf growth to be good when the GP is between 50% and 100% (the best possible growth occurs at a GP of 100%). However, when weather conditions are either too hot or too cold for optimal turf growth, the GP falls below 50%, and turf becomes progressively more stressed. When the GP falls to 10% or lower, growth is extremely limited. Appearing below is your model specific to The Briarwood.



Soil Testing | GREEN

The following tables represent the calculated MLSN values and required elemental inputs based on the provided nitrogen input and the Turf Growth Potential Model.

MLSN Values (ppm)

K	P	Ca	Mg	S	Fe	Mn
73	30	338	52	11	44	6

Required element per area (lbs. per 1000 sq.ft.)

Area	K_2O	P_2O_5	Ca	Mg	S	Fe	Mn
1	-	-	-	-	-	-	-
2	-	-	-	-	-	-	-
7	-	-	-	-	-	-	-
11	-	-	-	-	-	-	-
13	-	-	-	-	-	-	-
14	-	-	-	-	-	-	-
16	-	-	-	-	-	-	-
Average							

Note: - means no deficit was found; an empty cell means no data was provided. The Average values are the means across all areas where a deficit was found.

7.4

pH

The average pH is 7.4. This is within the optimum range for soil microbial activity and soil nutrient availability. This represents a .23 decrease from the spring testing average.

2.4
%

Organic Matter

The average organic matter is 2.4%. This is OK. Keep consistent cultural practices to dilute and manage OM. This represents a .08% decrease from the spring testing average.

2.8
ppm

Total Nitrogen

The total available Nitrogen measurement is the sum of the Ammonium (NH_4-N) and Nitrate (NO_3-N) measurements.

This is OK. However, consider increasing the amount of nitrogen applied to raise the available nitrogen between 5 ppm and 10 ppm prior to winter. To raise the total nitrogen to 7 ppm, apply .15 lb of N per 1000 sq.ft.

145
ppm

Potassium

The average potassium is 145 ppm. This represents a 34 ppm increase from the spring testing average. None is required as fertilizer.

71
ppm

Phosphorus

The average phosphorus is 71 ppm Mehlich III. This represents a 26 ppm increase from the spring testing average. None is required as fertilizer.

1127
ppm

Calcium

The average calcium is 1127 ppm. This represents an 8 ppm increase form the spring testing average. This is more than enough of the 343 ppm required. None is required as fertilizer.

167
ppm

Magnesium

The average magnesium is 167 ppm. This represents a 26 ppm increase from the spring testing average. This is more than enough of the 55 ppm required. None is required as fertilizer.

85
ppm

Sodium

The sodium levels reported are OK. The average is 87 ppm. This is below 110 ppm which is a threshold for sodium levels in bentgrass media.   Sodium levels have remained stable. Green 11 continues to report the highest levels at 111 ppm. As we have discussed before concerning green performance during extended periods of dry weather and relying upon the irrigation system, periodic soil testing during the summer months may be recommended to determine if there is a sodium problem and to what extent.

58
ppm

Sulfur

The average sulfur is 58 ppm. This represents an 8 ppm increase form the spring testing average. This is more than enough of the 15 ppm required. None is required as fertilizer.

192
ppm

Iron

The average iron is 192 ppm. This represents a 62 ppm increase form the spring testing average. This is more than enough of the 45 ppm required. None is required as fertilizer. Apply iron as needed to correct chlorosis symptoms when they appear.

88
ppm

Manganese

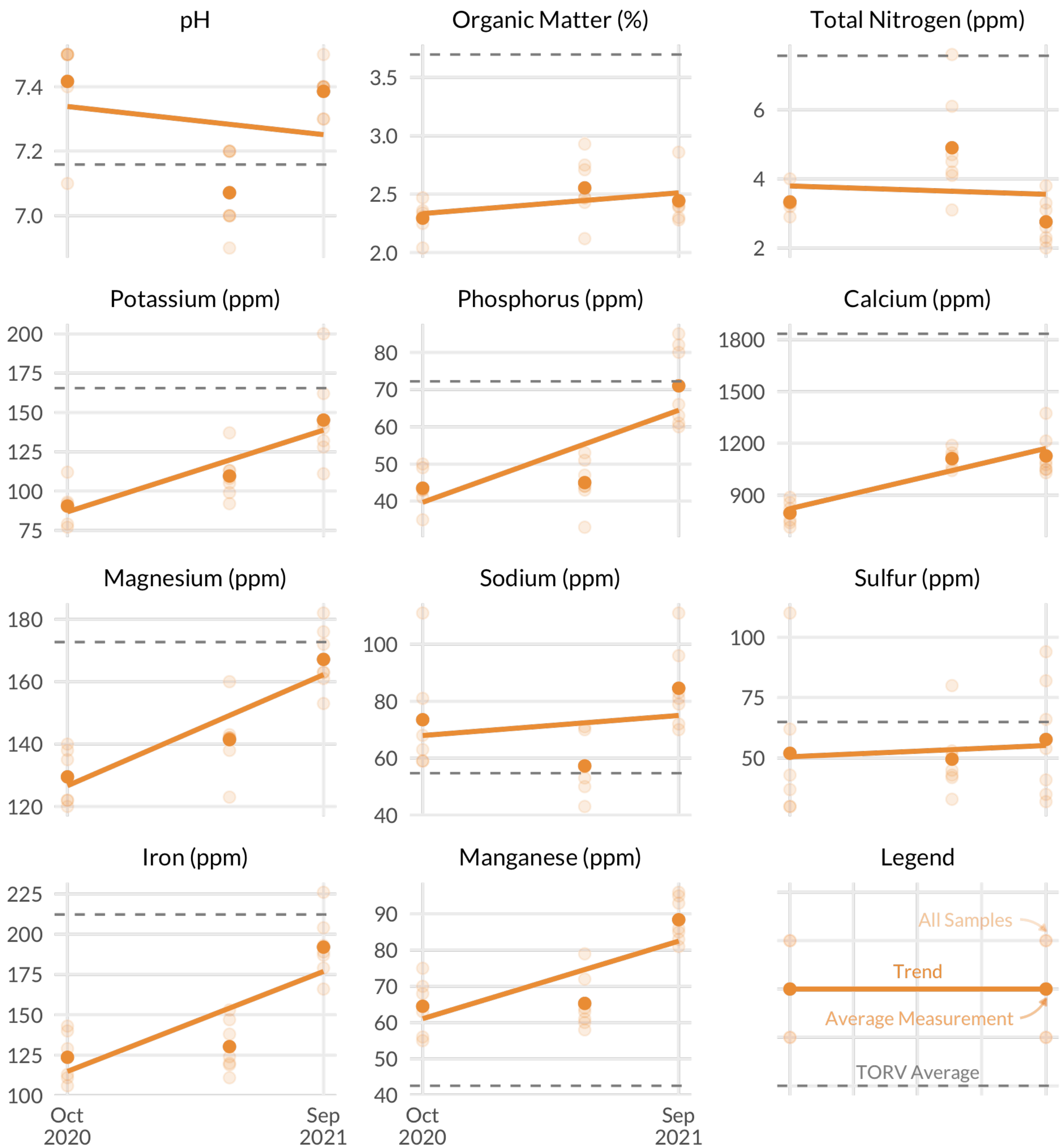
The manganese is 88 ppm. This represents a 23 ppm increase form the spring testing average. This is more than enough of the 6 ppm required. None is required as fertilizer.

Micro
nutrients

Micronutrients

All are present. None are required as fertilizer.

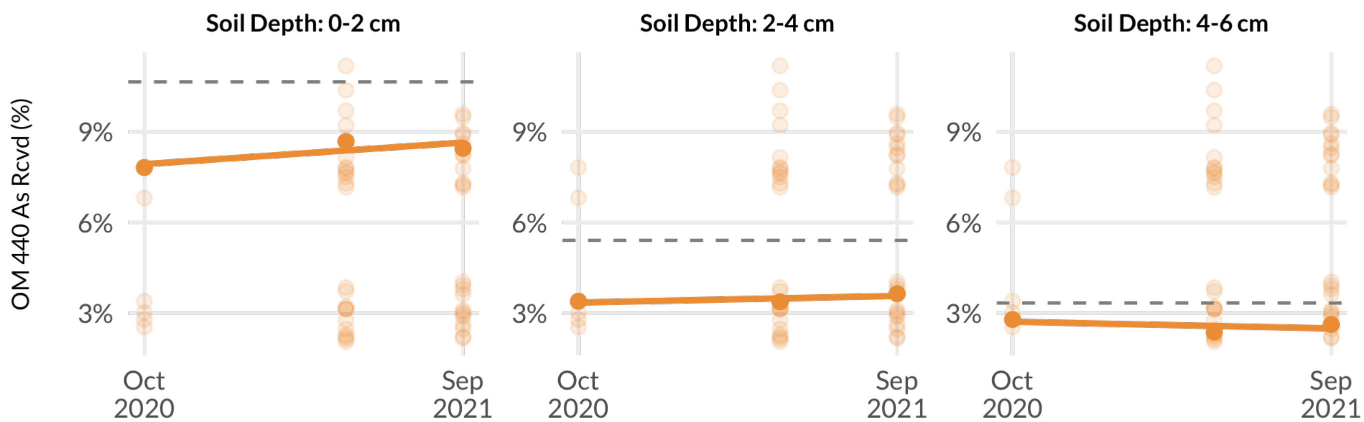
Trends Over Time | GREEN

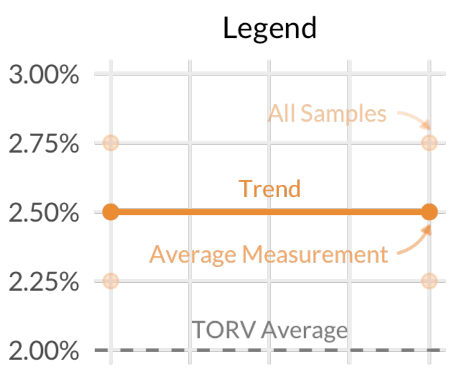


Organic Matter | GREEN

These measurements are neither good nor bad. Information such as fertilizer applied, cultural practices, sand applied, verti-cutting, aerification, etc. can be used to see how these practices have changed the OM% by depth. Ideally, once a desired OM% has been identified based on playability and turf performance, fertility and cultural practices can be adjusted to maintain the desired OM%.

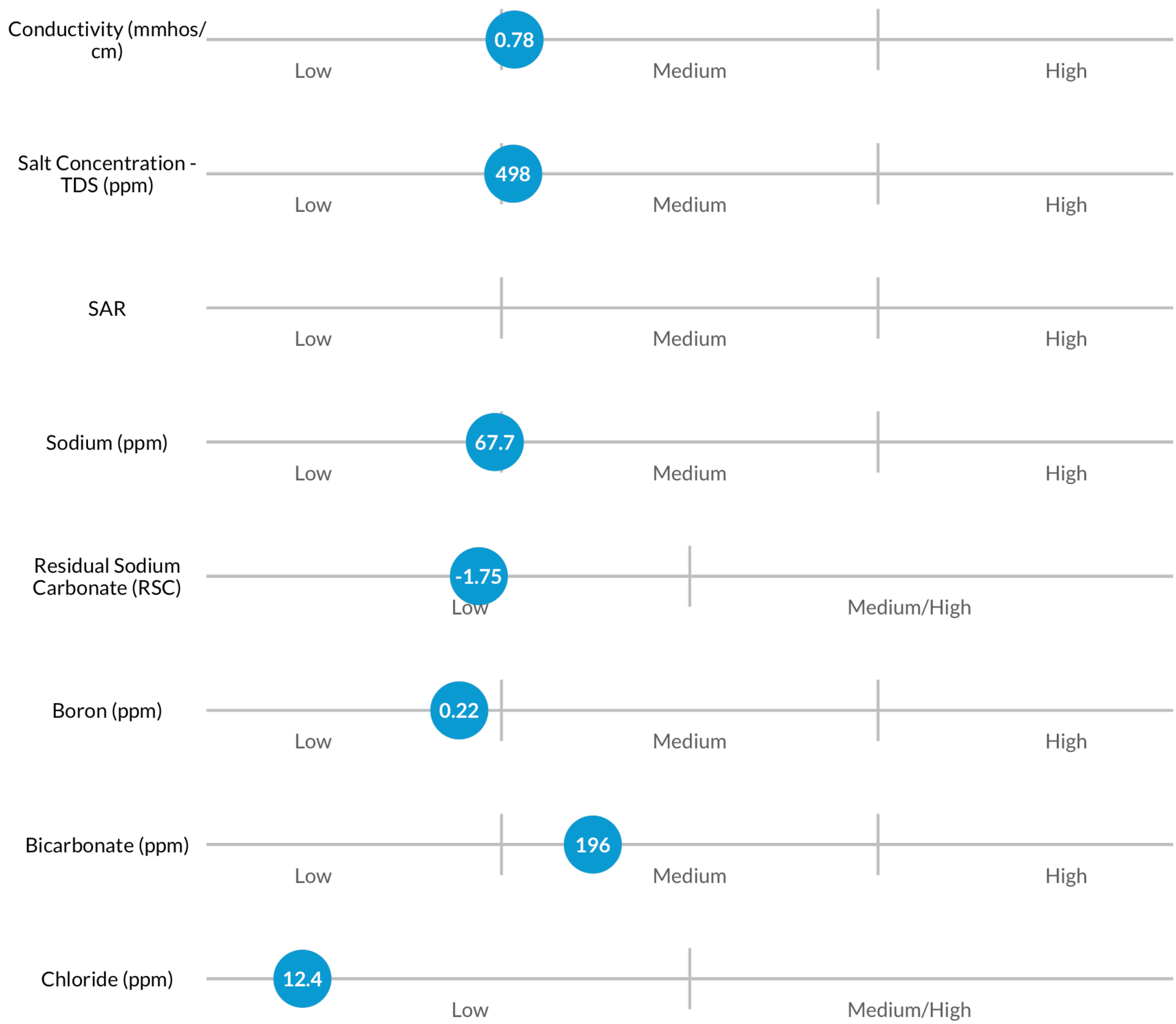
The S325 test package includes the entire sample submitted. This includes leaves, stems, and roots. This differs from the standard soil test which filters out most of the components. This is the reason why the percentages appear higher than that on a standard soil test.



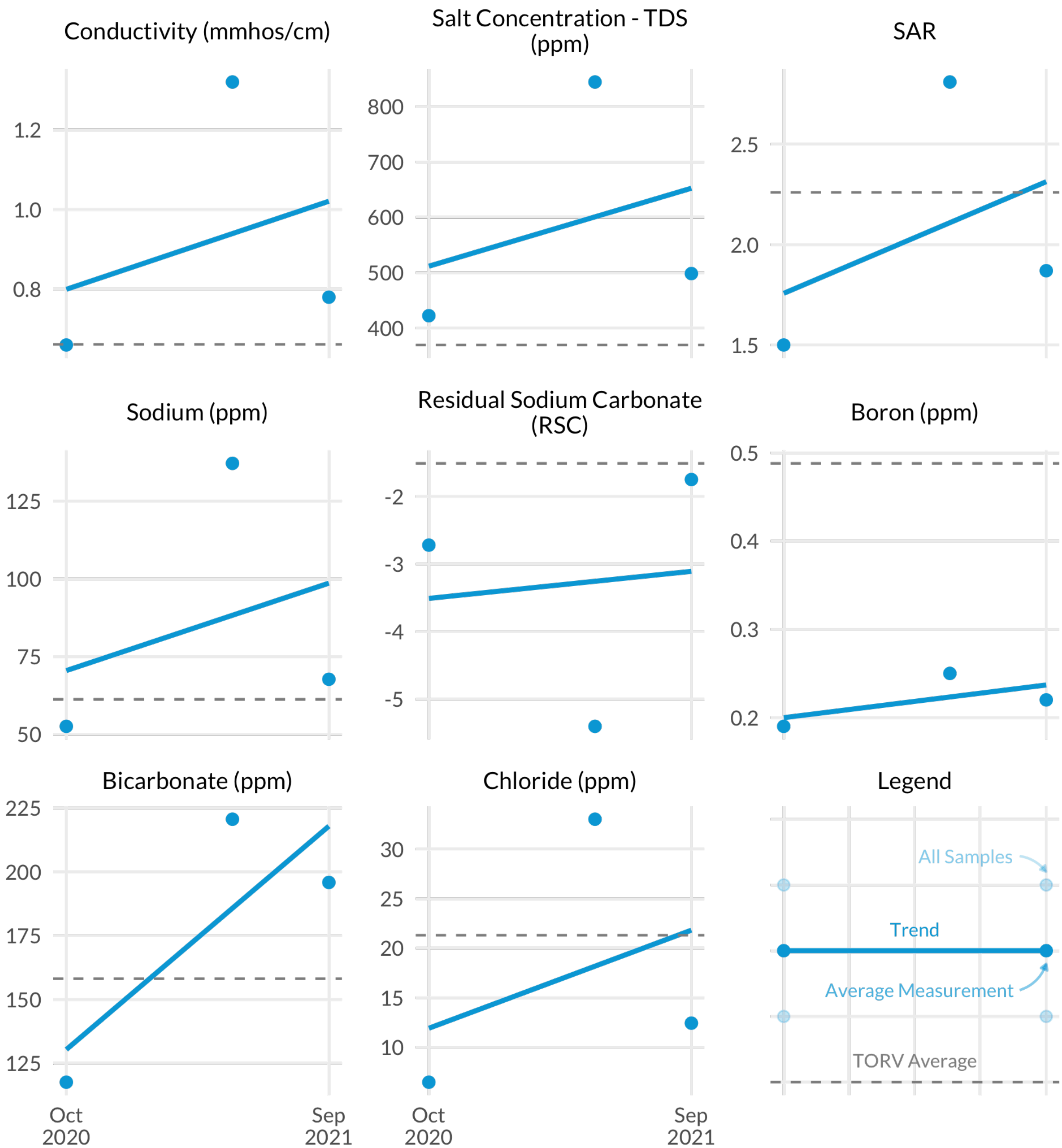


Water Testing | IRRIGATION

FAO Handbook 29 is the Food and Agricultural Organization of the United Nations and widely is recognized as the leading source for irrigation water quality guidelines. Below are the water sample results as shown in comparison to the FAO guidelines for likelihood of soil problems.



Trends Over Time | IRRIGATION



Water Testing | STORAGE

FAO Handbook 29 is the Food and Agricultural Organization of the United Nations and widely is recognized as the leading source for irrigation water quality guidelines. Below are the water sample results as shown in comparison to the FAO guidelines for likelihood of soil problems.

Trends Over Time | STORAGE