



MEASURING SOIL WATER POTENTIAL TO MAXIMIZE FARM WATER USE

Featuring Leo Rivera

Research Scientist, Director of Outreach

METER Group

DJ May 00:01

Welcome to the Decode 6 Podcast, where we take your questions about carbon and ecosystem services and match them to the experts with the answers. I'm your host, DJ May. And here's today's big question. What is soil water potential? And why should you measure it? Answering that question is our expert Leo Rivera. Leo is a research scientist and Director of Scientific Outreach at METER Group. He holds undergraduate and master's degrees in soil science from Texas A&M University, where his research focused on the impacts of land use and landscape on soil hydraulic properties. These days, though, Leo is leading meters collaborative research efforts. And he spends a ton of time on research and development exploring new instrumentation to measure water and nutrient movement in the soil. So it's fair to say that Leo is a great person to tackle this soil water question. Leo, welcome.

Leo Rivera 00:55

Thanks, DJ, I'm excited to be here.

DJ May 00:56

Awesome. Well, we're gonna get straight to it. So what is soil water potential? And why do we care?

Leo Rivera 01:03

That is a really good question. So soil water potential in its simplest form, you know, there's a super technical definition of it, which is in relation to a free standing body of water and, and all of these things, but really, in its simplest form, it's the amount of energy it takes to pull water out of the soil. And it really governs a lot of things that governs how available the water is to plant, it governs how available that water is to move. And it tells us when the profile is full. So there's a lot a lot of things that it controls, it is really the primary governing factor and water and soil. Okay, so from, you know, an agricultural perspective, we're thinking about this. When does that become important? Like, when do I start thinking about soil water potential, and like my field or my research plot? Well, you know, I think most growers, you know, I think they hit know that water potential exists, but they probably think about it in terms of water content, and they think about it in terms of, oh, I have I know, this is an optimal water content for my crops in this field. But really, what they're relating that to is really the availability of the water to the crops. And so they're thinking about it all the time. And they should be because it controls everything. And if you're not in the right levels, in terms of water potential, you're they're going to be way too wet, and you run the risk of disease and things like that. Or you're going to be way too dry. And you're in the risk of stressing your plants out and not being as productive. Although in some cases, you may want to do that. So in some crops, you want to actually purposely stress your plants at certain growth stages, like in wine, grapes, and things like that to increase sugar production. But what is always comes back to water potential, it's just how are we looking at it? are we actually looking at it in terms of water potential? Or are we looking at in terms of water content? Or maybe something else?

DJ May 02:51

Okay, so walk me through this relationship here. So we have, you know, plant available water and soil water potential, and water content? Are we talking about the same thing with everything? Or does it make a difference? When you start to measure things like how you look at it?

Leo Rivera 03:05

It is pretty much the same thing. You know, one of the most common things we use to relate these things is the soil moisture release curve, or the soil water characteristic curve, whatever you call it, different industries, different people call it something different. But there's always this relationship in every soil between water content and water potential. And then we use that relationship to divine define the plant available water. So we know, all right, our field capacity if we want to refer to field capacity is minus 33, kilopascals. So we know Okay, in this soil, this field capacity might be 35%, volumetric water content, and then permanent wilting point is minus 1500 kilopascals. So in this soil, that's going to be 21%, or 15%, water content, but we use this information to make all of these relationships. But water potential is again, that driving factor and so if we know the water potential, it actually makes our lives so much easier. Because then we don't have to do all these relationships and all these inferences. We know exactly what's happening. We know what the plant is feeling. And yeah, it's just a super powerful tool.

DJ May 04:12

Okay, and I'm guessing it makes a difference like what your soil type is when you're thinking about water potential?

Leo Rivera 04:18

That's the beauty of water potential it doesn't in when it comes to water content, yes. Okay. And that's why we love water potential because it's regardless of soil type, water potential is the driving factor that controls things. And every soil type does have a different relationship like we refer to the soil moisture, at least curve as being the fingerprint for soil, because every soil depending on its density, organic matter. Texture, that all impacts what that soil moisture at least curve looks like. But when it comes to plant relationships, water potential is water potential. And it's regardless of soil type. Now it does change where the water content levels are for that. But, again, it's that driving factor that really controls things. Great. Okay, so that seems like it really simplifies things. If I wanted to get out and like measure something, soil water potential would be it. It is it really would be if if everybody was comfortable making those measurements. Okay, well talk me through it. If I wanted to start doing that, what would it look like? Yeah, so that, you know, historically, and maybe this is why we talk about things in water content so much is, water potential is a hard thing to measure, it's, there's not one sensor that covers the full range of water potential. Now, that's something that a lot of people are working on, including ourselves, to try and make a better sensor that covers that full range. Some sensors require a lot of maintenance, like Tennessee, amateurs, you have to come out and fill them. And it's just a lot of work. Whereas water content sensors are easy. They're, they're really easy to use. So it's historically has been challenging. And I would say we've made significant strides in that area, with the technology, and what we're trying to do, and also then now trying to get more information about okay, what does this actually mean? What are optimal water potential ranges for different crops? So all of that

information is there. And it's just about getting it in front of growers and making it more available and more understandable. Okay, so is it easy? I mean, you mentioned, it's really hard to take that measurement and no sensors really doing it right now. But are most people monitoring through like a water content? meter? Is that kind of the standard? Or our people essentially? Yeah, yeah. So there's a couple different ways of doing if you're not directly measuring water potential with a sensor, you're either measuring water content, and you've made some inferences about what are the right plant avail? What are your fuel points? Right, what is what's my top off point for that based on fuel capacity, and what's my lower threshold. And ideally, we're not getting to that lower threshold, because that means we're really stressing the plant out if we're getting down to that range. But we're, we're going to use water content relationships to do that. And that means I have to know, okay, this is the soil type I'm working in, that means these are my fill points. And that works well, unless those properties start to change, especially as we start making different managers or adjusting our management practices, I think things like what we're doing in terms of soil health are really going to impact with they call it these dynamic soil properties. And so they change over time, as textured or as the structure changes, we get increases in organic matter, root, biomass, all these things are going to impact that. So that's the challenge with using water content to make that relationship. And then other people also use petal transfer functions and things like that to make these relationships. So there are ways to do it. And they're, they're not necessarily ideal, but it's only honestly, the best thing we have to work with, or have historically has been the best thing that we've had to work with.

DJ May 08:06

Okay. Okay. Top of Mind, I know that there's a lot going on in terms of like, drought and water management and what's going on, I just recently moved to like the Wyoming area, we have the Ogallala Aquifer, everyone's obviously worried about that in the Colorado River. But when you think about like how hard it could be to maybe switch over to a more precise management of like water and nutrients and using sensors? What are the barriers that like, could keep you from doing this? And how could you get over them?

Leo Rivera 08:36

Yeah, that's a really good question. You know, I think the biggest barriers are, are maybe just lack of knowledge, and understanding of the tools that are available to do that. And also, you know, making the tools easier to use the data more easy to digest and use that to make decisions. And I mean, that's what we spend a lot of time in, on our side is, is trying to make the sensors easier to use, and that information easier to digest. But then it also means we need to get more information in front of growers like okay, these are your optimal ranges, like if you can target these and try and stay within those ranges. I mean, we see this and this is not a perfect example. But in turf grass scenarios were like oh, yeah, we're we've got our irrigation dialed in. We've we're using evapotranspiration to set our irrigation thresholds. And then we look at how much water they're putting into the soil. We look at it in terms of water content and water potential and like they're saturating the soil and they're using so much water and they could dial that back, reduce their water usage, still have a healthy turf grass or a healthy crop, whatever. Just by using that information to dial in your irrigation strategy, so you're still keeping the plant happy, but not overusing the water that you that the water that's available.

DJ May 09:57

Yeah, yeah, well, I could see, I mean, I would consider myself, like fairly risk averse. But like, if I was worried, you know, my first instinct wouldn't be like to cut back water. Right? You know, but if you have that measurement in front of you, and you can see, like, okay, we're like in the right range, I'm sure that makes a huge difference.

Leo Rivera 10:14

Yeah, and honestly, that's gonna be one of the biggest challenges is getting people to trust the data. We, I mean, we see this all the time. And but over time, and we've had some really good wins with a couple growers in Idaho, they're grown potatoes, and potatoes are pretty water sensitive, they, they, they don't like to be too wet, and they don't like to be too dry. And so we've been able to work with them to use, we use some remote sensing to kind of characterize where the variability was in their field. And then now they're directly measuring the water content in the water potential. And they've really fine tuned that range. And it's increased their production and like their, their, their yields. But at the same time, they're seeing less issues with disease, because they're not getting your they're not keeping the soil to wet even though and especially sometimes they didn't realize that they were keeping the soil is what it was, what is it was so no, that's great. That's great. Now, when you I don't know, if you talk to these farmers directly, but like, what kind of feedback did you get after that process when they kind of saw the positive effects of measuring? Yeah, that's actually the most fun part. And, and so I've worked somewhat directly, along with Colin Campbell, who's worked really directly with these growers. But it's really fun the first time they start seeing the data, they question it, right? Well, is that right? I have my kind of historical understanding of the land and the fields. And then we just work, encourage them, like, look, trust the data, it, it's telling you what's happening, try to hit these ranges. And then at the end of the year, when they finish harvest, and they look at their yields, they were just blown away by the increase in yields that they saw in these fields, just from simple things like that. And after that, they wind up outfitting more of their fields, because they're like, Wow, this is such a powerful tool for me. And it's been super fun. And they have loved the tools, they get up in the morning every day and look at their data. And it's, you know, that's the things that make us happy because I love looking at data. It's one of my favorite things to do. We have projects out here. And over the weekend, I was like, Oh, I wonder what my irrigation is looking like looking like. And so I started looking at the sensors. So it's really cool when we see them seeing that they have that same level of excitement about it.

DJ May 12:32

No, that's great. And I want to double back to one last thing, you mentioned that you guys are thinking about tools. What's out there right now? Like what could somebody get started with? That's pretty accessible.

Leo Rivera 12:44

Yeah, there's a lot of there are a lot of tools available to measure water potential. And really, the key is understanding what range of water potentials you want to keep your your soils within, for example, plants that need to stay really wet, we need a more precise sensor, like a tensiometer, to monitor the water potential. And so those are the more higher maintenance sensors. But for that application, that's the better tool to go with. And there are more options that coming around that

are less expensive, that also send the data to the cloud, that way you can monitor that data remotely, you don't have to come out to the field every day to download. So we have tools like that. And then for other plants that are maybe are less water sensitive, you can utilize tools, what we call a solid matrix sensor, which there's several types of solid matrix sensors out there. And there's a lot of information available about those different types of sensors. Those are great because they're maintenance free. And they're actually less expensive than, than, say a tensiometer. And you can install more to kind of cover some of that spatial variability. And a lot of these sensors connect to the same tools that we're talking about that that allow you to see the data remotely, and be able to make more decisions on the fly, rather than having to come out and check and download things manually.

DJ May 14:08

Now, that's great news. That's good. And here's my last like curveball question for you. If you had to, like sort of look, I hate that I'm asking this already. If you hadn't kind of like look into your crystal ball of like what's coming down the pipeline in terms of these tools? What do you see like what could things look like in five or 10 years?

Leo Rivera 14:26

Oh, no, I'm glad you asked that question. That's because that's the stuff that keeps us up at night. But that's what we what we love. My personal view, the ideal water potential sensor is going to be something that installable really easily and can be removed easily. So for example, we've seen a lot of profiles, soil moisture probes come out that are great. I want to see and this is something we're working on is a profile water potential sensor that you can get your water potential measurements at multiple depths. It's super easy to install and can cover the rain. A lot of potentials that are most critical for for, for growing plants. And I think we can get there within the next five years. That's That's our goal. And that's where I hope to see the technology go.

DJ May 15:15

That's great. Well, fantastic. Leo, thank you so much for your time today. It was great having you on.

Leo Rivera 15:20

Yeah, my pleasure.

DJ May 15:21

Well, that's it from us today, folks. If you're curious about ways to measure soil water potential, or about the tools that Leo mentioned, check out the show notes. And if you have questions about carbon and ecosystem services, we probably have the answers. Come visit us at decode6.org. We'll see you there.