# University of Minnesota Nutrient Management Podcast Episode "Micronutrient deficiencies"

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Maggie Frazier: Welcome back to University of Minnesota Extension's nutrient management podcast. I'm your guest host Maggie Frazier, communications specialist here at U of M Extension. Today on the podcast, we're talking about micronutrients. We have three members of Extension's nutrient management team here, Dan Kaiser, Carl Rosen, and Jeff Vetsch, to cover the basics and beyond. Welcome, why don't you each give us a quick introduction.

Dan Kaiser: Well this is Dan Kaiser, I'm a nutrient management specialist here at the University of Minnesota, my primary emphasis is on major agronomic crops, corn, soybeans, wheat, alfalfa, those types of things that are growing in Minnesota.

Jeff Vetsch: I'm Jeff Vetsch, I'm a researcher at the Southern Research and Outreach Center in Waseca, I work primarily in soil fertility research and collaborate with the faculty on campus and also my primary research emphasis is in nitrogen management of corn.

Carl Rosen: Hello, I'm Carl Rosen I'm an Extension soil scientist in the Department of Soil, Water and Climate and my area of expertise is nutrient management. I also teach soil fertility to undergraduates.

Maggie Frazier: So what crops are sensitive to micronutrient deficiencies?

Dan Kaiser: Well Maggie, it depends on what micronutrient you're talking about and that's really the main thing and one of the things I really suggest to growers is knowing what crops are sensitive is really important in terms of getting the most information out of your soil test report.

Dan Kaiser: That's one thing that I commonly see and I just saw it the end of January here, a consultant getting a soil test report back that has a number of micronutrients tested for, the soil test is indicating one of the micros is deficient. This one in particular was copper for corn which I typically don't have much of a recommendation for on mineral soils with that, so the thing you gotta really work with with some of these people when that's the case and they see some of

these reports back is identifying whether or not it really is an actual issue because a lot of times if there hasn't been a widespread deficiency with a crop we don't have a lot of information on it, particularly on soil test for what should be a good or sufficient value and also what we should be applying. So that's really been the challenge with it across the state is really identifying crops and their susceptibility to the deficiencies.

Jeff Vetsch: I got a question for Dan, would you say the same holds true for people that get a tissue test back from the lab that shows some deficiency in a nutrient for that particular crop as rarely really much of a concern?

Dan Kaiser: Well, that's a good question because a lot of what we see currently I think in the industry is tissue analysis reports reporting these deficiencies particularly with micro so zinc, boron, copper, I don't see as much with that, iron, I don't really bother with an iron analysis because those are really overly accurate for predicting deficiencies as well but one thing that has been interesting to me especially has been zinc, and I don't know Jeff, if you've seen this in some of your studies but, I mean I see instances where we see, particularly for applying zinc, we see increases in tissue concentration but a lot of times, even in corn which we know is more susceptible to a zinc deficiency that a lot of times those values are still around the low end of the sufficiency ranges.

Dan Kaiser: So while we know we increase it and I have data that says that that increase doesn't result in an increased yield, I mean the numbers are really on the low end and that's one of the things that has been, in my mind, is a thing we need to be looking at more is some of these sufficiency ranges and I've actually seen instances when high yield crops where the concentrations are a lot lower than what are in the lower yielding crops so sometimes we start talking about the tissue analyses that an increase doesn't always mean that we see that with increasing yield, I mean there's a lot of things in dynamics that can go on.

Jeff Vetsch: Yeah, and the trial that I had that was funded by AFREC, we had ten sight years, and we looked at tissue analysis at B6, B7, and how we treated that corn made a big impact on what the tissue concentration, our control plot had no starter fertilizer, then we had a control with 10-34-0 starter and then we had two treatments that added zinc chelate with the 10-34-0 starter and what would invariably happen at almost every site is once you added the starter fertilizer, it would reduce the concentration of zinc in the control and primarily it was just more biomass and a dilution effect in the tissue. And then as you added the zinc chelate, in many instances we wouldn't really see that concentration in the tissue increased by very much and it was rarely statistically significant increase.

Carl Rosen: When you say starter you're adding phosphorus there and there is a phosphorus zinc interaction, and so when you have a lot of phosphorus there sometimes that will depress the zinc a little bit and so that will also show up. And one reason why you put zinc in with your starter fertilizer, to kind of counteract that.

Carl Rosen: Another thing about looking at sensitivity in different crops, it really does make a difference, and which micronutrient you're talking about. So for example, something like soybeans, very sensitive to iron problems in the soil, whereas another crop might not, growing in that same soil show that problem. So it really does depend on the crop.

Carl Rosen: It also depends on the soil, so, for example, Dan talked about copper earlier on and he mentioned mineral soils but if you're on an organic soil, higher organic matter, small grains, particularly wheats, very sensitive to copper deficiency on a high organic matter soil. Particularly ones that are designated as organic, so usually about 20% organic matter. So you'll see problems associated with the type of soils, but on a mineral soil, the wheat will grow fine.

Dan Kaiser: I think the same thing for corn too you can say I think wheat and corn on those mineral soils there could be some issues. The other one too I get a lot on is boron for questions and then a lot of that comes from tissue reports coming back. The thing with boron though, we know that any of these micros that we can have issues with toxicity if we over apply them, boron is though, the easiest one to get into some of these toxicity problems, particularly in soybean production. I've seen actually where we look at trying to apply for soybean and in seeing the yield increase where we tend see more yield decreases with boron application and I've got some very nice pictures of boron toxicity in soybean in Minnesota just based on some of the results we've conducted. So that's one of them that we get reports at times, one that you have to really be careful on this because of the over application issues with it.

Dan Kaiser: Carl did mention iron with soybean. Iron chlorosis is a little bit different of a problem because the soils itself aren't deficient in iron, the plant itself can't take it up. But we know that certain iron products, EDDHA chelates of iron tend to work well in terms of supplying iron to the soybean plant. So that's one where it's not easy to correct and you can only really correct it with specific iron chelates, there some of them that just have absolutely no impact.

Dan Kaiser: The other micros that are out there, manganese, maybe for soybean. One of the things that we've seen in the past a lot of questions stem around has been the glyphosate tolerant crops and there's been some clear evidence showing that these particularly Roundup Ready soybeans they have some issues right after application where we can see poor uptake of these metal nutrients, manganese, zinc, and some of these others at that key point in time. But a lot of times if you look at the data, essentially they'll start to recover within about a week or so, so it isn't always a given that just because these issues are noted that you're gonna see a problem with it. Chloride, that’s out there. Wheat is more sensitive to deficiencies, soybeans actually sensitive to toxicities of that one so that's one of them that you kind of have to watch out for.

Dan Kaiser: So that's one of the things of these, you just have to balance that with the information of what's good and bad because as I said you can actually overdo it and see some yield decreases with some of these micros.

Jeff Vetsch: And zinc in corn is a classic example of where you may see a symptomology in the plants at these younger growth stages and it really does not have any impact on yield later on, and that study that I did, we would choose 3/4ths of the sites and the study had zinc soil tests that were below the critical value, and we only had 2 sites that responded out of all of those.

Carl Rosen: And Dan talked a little bit about boron, so a crop like alfalfa for example, there's a crop that, if you are low in boron, there's higher probability that you'll see a response in to that boron relative to a crop like soybeans. And alfalfa's also tolerant to higher levels of boron than soybean so there's differences, you need to know the crop and sensitivity to that particular micronutrient and, to follow up on Dan's comment on iron, I don't know of any soil that's deficient, truly deficient in iron, it's usually an uptake problem by the plant. There's plenty of iron in the soil. If you did an analysis of that soil, there's plenty of iron there most of the time, it's just an availability problem.

Maggie Frazier: For zinc, what are the best source and placement options for crops sensitive to zinc deficiencies?

Dan Kaiser: This question comes up a lot and a lot of it stems from variable rate application. Now there is some options out there, but with broadcast, if you're looking at... I haven't really looked at what zinc sulfate prices are but I don't think they're overly cheap for zinc sulfate, but a lot of our recommendations you could go with the sight specific approach with the broadcast application and really target those areas that are low to try to bring the soil tests up because that's one of the things we've seen consistently with zinc sulfate applications is we can bring the soil tests up to more optimal levels and have multiple years of benefit from that particular product, but it's just a question of that cost benefit and whether or not maybe you've got a micros box or something on the spreader that can handle that particular material separately so you're not applying high rates because it's really hard to just get a set blend for that.

Dan Kaiser: But some growers I know of opted for looking at starter placement and that's one where, even with an infertile placement, that with source becomes I think a major issue particularly selecting a source that's gonna maintain availability over time. The chelated sources, I know they're gonna be a little higher for price, we typically see two of them out, a 9% and a 10%, the 9% is a more fully chelated source with EDTA, the 10% is a partially chelated source which can affect things, particularly if you have orthophosphate in the starter band where we can get some mixing and some combining of the zinc and the phosphate making some insoluble compounds, so it's a main thing just kind of looking at what you're

trying to do and then going from the source after that, and I know Jeff, you were I think, that starter, when you were working with the zinc sulfate in that particular mix, or was it a different product?

Jeff Vetsch: Yeah, in that trial we used the 10% chelated zinc with the 10-34-0 and really only in one site did we see a positive yield response to that. And then in the other treatments that were included, zinc sulfate broadcast, and we used it 0, 5, and 10 pound rates, and as Dan said the 5 pound rate was more than enough to build the soil test in those sites for significant number of years, but the practicality of doing that is primarily if you have that variable rate application and you can use that micro box on the spreader and just put it where it's necessary because zinc sulfate is not a cheap source of zinc to be applying if you're gonna put it on a broadcast all the way across the whole field.

Carl Rosen: So what are your thoughts on zinc oxide?

Dan Kaiser: Well I was just gonna bring that up, zinc oxide, because you look at MicroEssential's SZ, I mean that being a product that's all zinc oxide, and that when we start talking about variable rate, it's a good product in terms of having a good distribution of the zinc oxide. That's one thing I like about that particular style of product, because you're getting a little bit of it in every granule. The issue with zinc oxide, though, is it's solubility. That's one of the main questions, and I've had some success in acid soils of getting some similar soil test increase as it would with zinc sulfate so that kind of indicates to me that we're getting a similar availability but the questions always in high PH soils.

Dan Kaiser: And the other thing too is if you've got it, going back to what Jeff said, you have already blended in with the fertilizer material if you're doing a variable rate essentially then you're gonna be getting different rates that you really can't control if you want to be very specific on how much to apply.

Carl Rosen: Yeah, zinc oxide's very insoluble in itself so you need very fine granules or particles, and if it is coated, I assume it's very fine so there should be more surface area for it to react, but it's still very insoluble.

Jeff Vetsch: And that's a good point Dan when you talk about the PH interactions with zinc and some of the zinc sources is historically, when we think of the areas of the state that have zinc deficiencies, we think of southeastern Minnesota and some of the lighter, loess soils, and then also the soils in west central Minnesota and some in southwest, and southeast is generally gonna be acid surface soils, but when you get to southwest and west central you're gonna find more calcareous soils with high PH or some of those sources are gonna be better choices than others.

Dan Kaiser: Yeah, and it's a big question, there's a lot of options out there in terms of product, I mean we did some testing last year where I had some zinc oxide and

sulfate blends with some of these co-granulated products and we were more acid soils and it took essentially that we responded to rate and not source in those trials, so it took, I think 2 pounds, we didn't need a whole lot with that. So a product like the MicroEssentials SZ if you're applying that across all acres getting about a 2 pound rate, maybe there's some benefit to that. Really though, in terms of the soil test increase, that's the other question.

Dan Kaiser: With liquid sources I get questions because ammoniated zinc is always cheaper. I mean, again, the issue with that essentially is the reaction with the other liquid fertilizers you're mixing it with and we know with especially 1034 which has some orthophosphate in it or some of the other sources, if you start getting some precipitation that can be an issue if you get zinc phosphate precipitates in the tank. The other one that's out there that I haven't researched much, some of the products of zinc acetate, there's been research on a lot of these things historically, I just haven't really looked into all of it.

Dan Kaiser: So there's a lot of options out there, the starter only is one thing I'm interested in because we're putting such a low rate on is that sufficient particularly in some of these low soils and that's been my main question. Can we get away with a quart of a 9% chelated zinc if we've got a soil test less than a half part per million and we'd have deficiencies show up in a regular basis, is that adequate?

Jeff Vetsch: And I think the other question for Dan for growers is that historically have added these chelated products to their starter fertilizers, if they don't have a significant number of grid cells or areas in the field that have a soil test for zinc that's below their critical value it's really not money that's very well spent, 'cause some of these chelated products are not cheap, even at these low rates.

Dan Kaiser: Yeah, and even when you look at some of these newer, bigger micro mixes too, I mean, zinc makes more sense to me, if you're putting a product in, than some of these other micros, but, I think that's what some of these growers have gone to because it's just an easier way to deliver it. I mean I think there's pros and cons, I mean, when somebody asks me that I'm gonna give them my general opinion on it, that looking at zinc is probably the more important out of anything with the full micros, but even then, as Jeff as you said, I mean, you may not see a large portion of your field that's deficient enough to warrant the application.

Jeff Vetsch: I know in our area, we see a lot of type of prophylactic, where the zinc chelate just goes in with the starter on every acre and I don't think that there's a lot of justification for some of those applications.

Maggie Frazier: How accurate are tools such as soil or tissue tests in predicting micronutrient deficiencies?

Dan Kaiser: This is a major question, I was alluding to this before when I talked about that example with copper is, you see a lot of labs anymore running a DTPA test, it

doesn't really make any sense just to run zinc on it which we'd normally just recommend looking at because the running of the analysis with ICP so they can get the other metals in, so you're gonna get copper, iron, manganese, all with zinc, don't really question against the accuracy of those tests is we don't have any established critical ranges for anything other than, likely, zinc. That's the only thing really that we've had documented evidence enough that we could actually say that, if you're below .75 part per million with the DTPA test, the response likelihood starts to increase and if you get below .5 down to maybe .25 or .3 then conditions were really low in zinc.

Dan Kaiser: So that's one I think is a little bit more of a given, copper on organic soils, as Carl was saying, that's been I think fairly well researched if you're on mineral soils typically you're gonna get a lower value probably then your organic. That doesn't mean that you can use the same interpretation for those two.

Dan Kaiser: Manganese, I mean, it's a question mark. Right now I've seen some data on soybean where we've gotten less than 15 part per million where it's been about a 50-50 shot where we've seen a slight yield increase on soybean, but again it isn't given. Manganese is one that I've kinda been wondering in terms of the value of it and then iron, again, really doesn't predict where the IDC's gonna occur.

Carl Rosen: Yeah, really what you wanna be looking at for some of these is the PH of the soil, may a better indicator of what might be happening than the actual soil test value for that micronutrient, particularly the metals. So as your PH goes up, the availability of micronutrients goes down even though the total amount might be in the soil, it's just an availability problem. But we do see, particularly with iron and manganese, to lesser with things but also with zinc and copper as that PH goes up you will have less availability, and so you need to tie that in to some of your tests as well.

Jeff Vetsch: So Carl, where do you think that concern is from a PH standpoint? Is it above 7 1/2 or does it have to be higher than that?

Carl Rosen: Yeah, I'd say 7 1/2 and those alkaline soils are where you're going to see the problem in mineral soils. It's much lower for organic soils, we have some acres of organic soils but it is a lot different in terms of the PH interpretation on those organic soils more than that 6 1/2 to 7 range you'll start seeing problems.

Dan Kaiser: A lot of that issue with the organic I think comes from the fact that you can get some chelation with those organic so you can actually get a higher concentration but it isn't necessarily available.

Carl Rosen: Yeah, what ends up happening there is it gets chelated but the organic compounds in the organic soils are so large that it chelates it but it's not like a

zinc chelate which is a small chelate that's soluble, it's just chelated and doesn't move anywhere.

Dan Kaiser: Boron's the other one and with boron, I've just finished up some field trials on this one and it's a nice relationship with organic matter, if you look at boron soil test so really tight relationship on irrigated sandy soils where we don't have a lot of organic matter you get a little more spread on non-irrigated in terms of the relationship between the two and with that one the only thing I've seen with that one on corn production, if we get less than maybe .1 part per million with that test that it might be some benefit there but typically I can probably predict that with organic matter, really low organic matter, sands there might be a benefit for corn, potatoes...

Carl Rosen: Yeah, and potatoes will see really low boron levels in those sandy soils and we sometimes get a response, particularly in tuber size distribution with boron but rarely do we see a yield response, it does affect the tuber size distribution if you're too low.

Dan Kaiser: We mentioned this before, tissue tests, I just am not confident on the current sufficiency ranges that are being used because one thing that we haven't addressed essentially is everybody, I think, assumes that as yields have increased that our sufficiency ranges should increase and I don't think that's the case, I think we're actually seeing where, if anything we're more efficient, and we're seeing maybe them drop down a little bit more where we're seeing some dilution here because those plants are putting out more biomass, or there is just something else going on with that, particularly with zinc, zinc's been a big one where I've seen consistently levels around 20 part per million when we've applied zinc and we've had no yield response. And that's I think the key with the tissue test is if there's data behind it that has some response data because if you don't have that, I really have no confidence that that value means anything and that's one of the things I've been struggling with, and then the other thing with a lot of these, they can correlate very well to some of the major macros, nitrogen, phosphorus... So if you get a problem with one of those then you can see problems with some of these other ones and I think if you correct the macro then the micro deficiency would just go away.

Maggie Frazier: Alright, if someone encounters a deficiency in season, can foliar application of micronutrients correct it?

Dan Kaiser: This is a good question. Really it boils down to how your assessing it and again a lot of this comes from tissue analysis. One of the things, though, that with a foliar application, if you look at it to think historically, there's been better results in data in perennial crops, not as much in annual crops, with an application. In terms of application of these one of the questions I've had with this if it is deficient, most of these metals, particularly it's micronutrients, are immobile in the plant, so even if it does penetrate into the plant which we don't really know,

the chelates may have a chance to penetrate the leaf, if they don't translocate then, essentially are you just putting a temporary Band-Aid on it and that problem's gonna persist.

Carl Rosen: So, usually, if you're going to try to correct it with foliar, you need to do multiple applications. But, something like iron, once you see symptoms, I've never seen a correction with foliar.

Dan Kaiser: Yeah, iron chlorosis in beans, they've always said you've gotta correct it before the problem you can see it.

Carl Rosen: And so, some of the micronutrients, it's just a losing battle once you start seeing symptoms.

Dan Kaiser: And that's where Jeff mentioned kind of those prophylactic treatments infertile, if growers are consistently going in with foliar applications I've just been kind of scaring them towards to going to that route if they've got a liquid infertile starter because if you're gonna do it, why not just do it once and forget about it and not worry to much about it? Then at least you're feeding roots and it can translocate where it's needed. I haven't really been a big fan of it, I mean I know there's recommendations out there, like copper and wheat in a few situations but as Carl said, you could take multiple applications so, you don't have a lot is there enough time to invest in something that may not necessarily make any difference.

Maggie Frazier: Alright, that about does it for the podcast this week. We'd like to thank the Minnesota Agricultural Fertilizer Research and Education Council, AFREC, for supporting this podcast. For the latest information on nutrient management, you can follow us on Facebook and Twitter at UMN Nutrient MGMT where you can also send us your questions for future podcast episodes. Thanks for listening.