

University of Minnesota Nutrient Management Podcast Episode: A conversation on sulfur

February 2019

Written transcripts are generated using a combination of speech recognition software and human transcribers, and may contain errors. Please check the corresponding audio before referencing content in print.

Maggie Frazier: Welcome back to University of Minnesota Extension's Nutrient Management Podcast. I'm your guest host, Maggie Frazier, Communication Specialist here at UofM Extension. Today on the podcast, we're talking about sulfur. We have three members of Extension's Nutrient Management team, Fabian Fernandez, Dan Kaiser and Jeff Vetsch, to cover the basics and beyond. Welcome. How about you each give us a quick introduction.

Fabian Fernande: Sure. I'm Fabian Fernandez at the University of Minnesota Extension and Research. I work primarily on nitrogen management for growing cropping systems. I've been here at the University now for five years. Hard to believe.

Jeff Vetsch: I'm Jeff Vetsch. I'm a researcher at the Southern Research and Outreach Center in Waseca. Work in soil fertility, primarily in nitrogen management of corn. I've actually been at that position for over 25 years.

Dan Kaiser: This is Dan Kaiser. I'm a Nutrient Management Specialist at the University of Minnesota. I spend a lot of time working with fertilizer guidelines. One of the major areas of emphasis I've had in the past 10 years since I've been here has been on sulfur management in corn, soybean and spring wheat.

Maggie Frazier: All right. Can you talk a little about some of your first encounters with sulfur deficiency in corn, in medium and fine textured soils?

Jeff Vetsch: Yeah. We first kind of started noticing that there was something going on, primarily from a research standpoint, in the early 2000s, but prior to that, in the '90s, when we did a lot of manure research, we would always compare nitrogen, fertilizer nitrogen rates to manure nitrogen rates focusing on nitrogen, of course.

Jeff Vetsch: The manure, frequently, on these medium and fine textured higher organic matter soils would have a darker green color, it would have a higher SPAD readings. We did chlorophyll meter readings, and often would have a higher yield, and we never quite could put a finger on it. We always kind of called it "the manure effect." Looking back, I really think some of that was sulfur nutrition and that sometimes we got a yield response to sulfur in some of those fields and sometimes we didn't.

Jeff Vetsch: When we finally started identifying sulfur as the nutrient was in a line study that we did at Waseca on a Nicolett soil that had about four and a half percent organic matter. That study ran from 1999 through 2006. We had six years of corn, five years of alfalfa, and only three of the six years of corn did we get a significant yield response to sulfur.

Jeff Vetsch: In one of those six years it was greater than 10 bushels, but again, we saw the same kind of physical plant health, where very early in the season when that corn was from V6 to V8, the treatments that got sulfur had darker green color, more biomass looked healthier. That was kind of when it really started opening our eyes.

Jeff Vetsch: In alfalfa, we only had one of five site years, but there was no with lime and with sulfur treatments, so wherever we put sulfur in our alfalfa studies, they actually were pH deficient. I think we needed the synergy of those two things together to see a better yield response.

Jeff Vetsch: Then the next study that we looked at was a starter fertilizer study that had both N, P, K and S in different combinations at different rates. That was really the big eyeopener where we saw an average eight bushel yield response over the three years. In 2006 in our study that was corn-on-corn, we had a 20 bushel yield response to just four pounds of sulfur. That was really kind of that earth ... Eye awakening moment where, "This is a nutrient that we really need to pay attention to."

Dan Kaiser: Yeah. When I came here to Minnesota, I started in 2007. I was at Iowa State before that, and just out of Northeast Iowa. Brian Lang, one of their field crops specialists up there, I know him and working with John Sawyer off of campus. They were looking at sulfur around the Decorah area, in some of the rolling, kind of the lush soils up in that area, seeing a lot of responses. That's kind of the first time that I had been aware of it. Then when I started in Minnesota, I had a few consultants kind of in my ear in terms of some issues they were seeing.

Dan Kaiser: Then we started some strip trials looking at N, P and S for both corn and soybean production. The corn years, I mean, particularly 2009, when we had that really cool year, that was the year that the site we were on, we had a pretty rolling topography and really low organic matters, and there was some huge responses, like 60, 70 bushels at that particular location.

Dan Kaiser: It's been interesting because a year does make an impact, because we got into 2011 and '12, we had some really good years and then '11 and '12 really, then we started to see a little bit drier conditions and the responses weren't quite as much. The last two years, I mean with the wet conditions we've had, particularly ... Like Jeff was saying, what's surprised me is the area around Waseca there, I

expected maybe the Southeastern part of the state, some of those set loam soils to respond, but we've been seeing pretty consistent responses in these higher organic matter, poorly drained soils, particularly in corn-on-corn systems.

Fabian Fernande: Yeah, and for me, I came from the University of Illinois, I was a faculty member there. It was similar to what Jeff and Dan mentioned, that it was in those early 2000s that people started looking at that and started to see issues. That was no different in Illinois. There were consultants and farmers that talked to me about it, and so we decided to do a study.

Fabian Fernande: We had done, as a university, before I arrived there, there had been some other studies in the '80s. There was very little response, and so I was a little suspicious, what was going on. Sure enough, we did the study and we found that there were locations where it was ... We obtained some response in some locations as particular sandy soil, which they are not that many of those in Illinois. We actually got over a 50 bushel yield increase with sulfur in there. Was just strikingly different compared to the no-sulfur treatments.

Fabian Fernande: The other part that was interesting was that not all the soils that responded were the coarse textures or light textured soils, there were some pretty good high organic matter soils that also responded to sulfur. That was an interesting thing. I think part of why we are seeing these things is that with the cleaner air, we don't get as much sulfur deposition.

Fabian Fernande: We used to, if you look at maps of sulfur deposition across the Midwest, we were getting anywhere from 20 or more pounds per acre per year deposited from the atmosphere, so basically free sulfur fertilizer for our crops. That has really dwindled to almost nothing now. Some of the regulations have been cleaned the air from power plants and things like that. I think a lot of what we are seeing now is the fact that we are not getting that free sulfur from the atmosphere.

Dan Kaiser: Yeah, and I mean legacy does have a big impact, particularly previous applications, as Fabian was saying. Some of those just repeated applications year after year from the air. I think looking at that over time ... I mean, as Jeff was saying, it was interesting. Jeff mentioning kind of some of that stuff in the '80s, seeing that as ... You saw those trends of the atmospheric deposition go down.

Dan Kaiser: I mean, it does make sense. You start looking at that and those additions starting to dwindle more and more. It's just starts to become more and more deficient as we start increasing our yields and putting a little bit high, greater demand. Although we know that demand hasn't changed greatly with sulfur. I mean, we're still looking at about 25 pounds in corn production, being what's

taken up on an annual basis, maybe up to 30, kind of depends on- [crosstalk 00:07:48]

Jeff Vetsch: Usually around a 10 pound removal or somewhere in that neighborhood.

Dan Kaiser: Yeah. I mean, that's one of the things I think in terms of finding sites. I know back in about '11 and '12, I was wondering because they were looking to find a responsive site again because most of the growers have already just, already took to the information that we were showing and started applying. Then we're seeing just the levels that were carrying over the soil started to increase again because we're starting to get to levels that were additions like we were seeing with some of that acid rainfall.

Dan Kaiser: It got to a point at which we weren't really seeing a whole lot, but then we've been getting kind of a wetter cycle now and I think we're seeing some more of that start to drop down and some of it could be source as well. I mean with, we know that elemental has some issues with oxidation, that some of the growers are applying that, so there may be still some issues there.

Dan Kaiser: It's been interesting. It's been a roller coaster a little bit in terms of responsiveness and really depends on the year. Cool wet years, tend to see greater potential. Particularly since I think a lot of our troubles come early in the growing season. I mean, we only need roughly about 10% of the total uptake by about V6. That's a critical period for us, where we have some soils that we just, that crop, can't get it out of those soils.

Fabian Fernande: Yeah. Jeff mentioned that, the affect of manure and I think when you think about deposition, having less deposition and legacy of manure. We don't have as much manure applications as a whole in the state as maybe we had in decades earlier. Excuse me. Then fertilizers also have become more clean. They usually have more impurities with sulfur, and we don't have as much of that. All of that combined, I think, has resulted in what we are seeing more commonly now with responses to sulfur.

Fabian Fernande: One thing though that I would mention is that with sulfur, it's important to really see if you are getting a response to sulfur or not. You don't have to go and apply sulfur in every acre just in case, because you will see the deficiencies and it will be clear that they are there. If you don't see those deficiencies and you are curious, you can do a trial to see if you get a response, but it doesn't mean that you will see responses everywhere all the time.

Dan Kaiser: I see current, I mean some of the current genetics, sometimes they'll have a tendency to stripe. I'm not too concerned about it if it's just the upper leaves, so that one leaf on the top that you see some faint striping on it. You start getting

below that, and you start to see it real striking that yellow, interveinal striping on it, then it's likely going to be more of an issue.

Dan Kaiser: I've seen that where we've applied sulfur even at 25 pounds, where we still see some of that striping, I think it's just a crop, it can't meet the demand as fast as it's growing early on, so it has a little bit of a tendency to show some faint ... If you look at interveinal striping, but it isn't anything that's really clearly visible unless you really look at it.

Jeff Vetsch: There's definitely crop interactions with sulfur fertility. First off, we've talked primarily about corn and that's the key one, but also thinking of forages, demand for sulfur. Then when you get to the small grains, it seems like it's just, it's more of a hit or miss of whether you're going to see a response to sulfur in small grains.

Fabian Fernande: Dan, you mentioned the early part of the growing season. I think that that's kind of where I would make sure that I look at the crop closely during that early part of the growing season. If you see some striping developing, that may be an indication that, "Okay, maybe I should dig a little deeper and see if this is really a problem or if it's just a reason of the season."

Fabian Fernande: If it's a wet, cool season, you may get some deficiency, but it will be a temporary thing that the plants will come out of it once it warms up and you start getting mineralization from that soil. That would be kind of the first step in deciding, "Do I need sulfur?" Well, if see those stripes early on, it may be telling that you're getting close to needing to apply sulfur.

Maggie Frazier: What have you found when comparing fall and spring application of sulfur?

Jeff Vetsch: I think it gets back to Dan, what you mentioned earlier about the kind of climactic interactions you have in the spring. I think that some of our inconsistent performance of some of these fall applications are really driven a little bit by the spring weather as well and the kind of year it's going to be. If it stays wet and cool in the spring, the sulfate sources are so important and it's probably best if they're applied in the spring.

Jeff Vetsch: If you're using something like elemental in the fall, I've had years in our trials where it did just fine and I've had years where it didn't do fine. I think it gets back to that kind of a climate for sulfur. Is it going to be a year when there's going to be a demand and a lot of deficiency? Or is it a year when it doesn't take that much and then elemental, you do just fine?

Dan Kaiser: I think it really depends on rate and how much you're applying and if you're really going kind of with our recommended rates are mainly, I think, based around what I would consider to be a spring application, particularly on the

lighter end of the recommended ranges. You have to be somewhat careful because we know we're probably going to move some sulfur ... The sulfate, if you look in the soil, doesn't move quite as quickly as nitrate. I'm really not concerned about it being completely leached out of the root zone, but there's still some risk there.

Dan Kaiser: The last couple of years I've had some fall, spring trials and the two sites that we had a response is at, the one was on a silt loam in the Southeast. That one definitely favored spring application and that was, would have been applying in the fall of 2016 for 2017 crop. We had a lot of rainfall, so it kind of made sense with that one. Then we had one last year in Waseca that responded. Then the fall, spring it really didn't seem to matter.

Dan Kaiser: That's one of the things that, I mean really, the leaching potential, it's there. I've seen actually where I can make a one year application, I see some of that sulfur, I don't know how much, but some of it carried over for more than one year, more than one ... One crop, more than one year out of application is still picking it up, so it really depends. I mean it depends a lot on application and that's one of the things that I know a lot of growers are concerned about with. Particularly if they want to put it in with P, N, K, if they're not doing any broadcast applications in the spring, they don't really have another option to put sulfur on.

Jeff Vetsch: Yeah. I think that's a great point, Dan, if you're putting on 20 or 25 pounds per acre for corn, in a corn, bean rotation, it probably doesn't matter when you put it on. I think when it matters is when you start reducing some of these rates down under 10 pounds. Then the timing and the place or the source is probably more important.

Fabian Fernande: The other thing too, which could relate a little bit to the fall versus spring application is the crop rotation and the type of tillage that you have. The soils that will be more propensity to be deficient early in the spring will be those where you have continuous corn or minimum tillage where you have a lot of crop residue. Those soils tend to stay cooler and wetter.

Fabian Fernande: In those situations, spring application may be better because you need to have something that is readily available. Fall applications, again, if you are using something more like an elemental form, it may not mineralize fast enough for that situation.

Dan Kaiser: Yeah. Well, I mean the oxidation potential, I mean, you look at how cold we are, I'd even say with the fall application, unless you're putting it on in September, you're probably not going to get much oxidation of those products, with an elemental sulfur product, so it's been kind of my question. I've seen that. Years, it was 2011. We had some studies looking at zinc where we applied sulfur, just blanket applied it.

Dan Kaiser: It was an area where it's primarily, I think a fall elemental and you could see my plots. Green little postage stamps out in the middle of the field. They got it a little stir within that neighborhood of where we're at. It was around the Grand Meadow area, and there was some supplemental sulfur that went on at that point in time just because it just wasn't available.

Dan Kaiser: I mean, that oxidation, it takes a higher temperature so it takes more to oxidize elemental than what we usually would see early in the growing season. That's kind of that balance, I think, between the two, I think becomes important to having a little bit of sulfate earlier. At least, getting some oxidized elemental, that's sulfate, that's oxidized out of that, carried over to the next year is really important to make sure that works.

Fabian Fernande: Yeah. Those oxidation things, situations where the oxidation is not rapid is also the same situations where you have these low mineralization of sulfur, so you have kind of both working against you, the plant just doesn't get enough.

Jeff Vetsch: You can actually end up with immobilization. Dan, I think you had some grad student that looked at that, where you can drive immobilization of sulfur in the right conditions.

Maggie Frazier: What is the best source of sulfur to use for corn?

Dan Kaiser: Well, I think we covered some of this. I think some of it depends on timing. I do prefer a sulfate if I can get it, elemental. There's just that question mark of oxidation potential. The other issue with elemental, particularly products like Tiger 90, are distribution. That's one of the things with low rates I think we consistently run into.

Dan Kaiser: I've compared them, say at 5 and 15 pounds, which kind of around, a little bit less and more than what we recommend, is you look at how those granules are distributed on the soil surface, and there's a lot of space between, particularly 90% product versus these other products which may be 15, 20% sulfur, so that's an issue I think you run into with elemental. I mean, that's why I'd probably not go more than less than 25 pounds with elemental product, maybe even more if you're getting such low oxidation.

Dan Kaiser: Then again, when you look at the overall costs, elemental a bit cheaper. You start increasing the rate, then you probably about a wash in terms of the two, in terms of a price. I mean, that's the main thing. Liquids, actually ammonium thiosulfate, I think's a good option with that product. Actually, if you look at it, how the thiosulfate ion is built, it has some elemental. When it [desulfates 00:17:46] it'll have sulfate, so you will get some of that extended potential release with that immediately available.

- Dan Kaiser: That product or some of these micro-central lines where you have kind of a blend of the two, I think would work well because you get that immediate availability, so for short, early on. Then you get some release later that probably isn't going to help us as much, but maybe it's available for further years if that oxidation, sulfur can be carried over.
- Jeff Vetsch: Yeah. I think the source is just what you said, Dan. It kind of goes with the farmer preference too. If they want to apply with their broadcast in the fall, then elemental is probably a good option because it's inexpensive but they're going to probably need a higher rate. Maybe they want to consider small amount of ATS or thiosulfate at planting.
- Jeff Vetsch: If they're going to go across the field in the spring with some application, whether it's Urea or something other, it just seems logical to use AMS and blend it in with that Urea during that pre-plant application. You really can't go wrong in that situation. We see a lot of a ATS going on with the planter in a dribble band. I think they like how that responds or that ... Especially in corn-on-corn, how that plant can respond to those treatments.
- Jeff Vetsch: We also hear a lot of stories about people who that are side dressing with liquid, 28% or 32% that are including some ATS in with that just to make sure that they have kind of season-long sulfur availability.
- Dan Kaiser: Yeah, and with it, I mean, one thing about AMS that, the omegas, my only drawback essentially would be the acidification. You have to be careful with high rates because we do know that it will acidify faster. I mean as a nitrogen source, it tends to do that. If you're already dealing with kind of marginally low pHs, I mean you may see a need for lime a little bit quicker if you're putting on a high rate of AMS.
- Dan Kaiser: Gypsum's out there. The solubility can vary of that product but overall, we've seen it does tend to work very well for supplying sulfur. I mean, some of the other products like K-Mag, Sul-Po-Mag or potassium sulfate, I mean the cost is a little bit higher when you start looking at those so you're probably more dedicated into the specialty market for some of those with higher value crops.
- Fabian Fernande: Yeah. With ammonium sulfate, it is a great source for both sulfur and nitrogen, but as Dan mentioned, the acidification is more acidifying nitrogen source that we have, but it does work well in situations, maybe towards the Western part of the state where you have more alkaline conditions, or in places where you are not able to incorporate the fertilizer. If you're going to leave it on the surface, ammonium sulfate is a much, much better source than Urea even with a urease inhibitor because you are avoiding the volatilization losses that you would have with Urea

Dan Kaiser: With sulfur, we don't have that volatility. That's one of the questions I get is, "If I leave it on the surface, will I lose sulfur?" We don't get that, so with those immediately soluble sources, it does tend to work better. With that application, the surface applications too, I've heard that actually ... The Tiger 90 rep was suggesting putting their product on to get it to fracture better.

Dan Kaiser: Because it's one of the issues with elemental is it's hydrophobic, so if you get into the soil, it doesn't really dissolve very well and it can kind of clump back together as some of that bentonite is releasing. Then some things with their ... I mean, I just, in terms of availability, if you want immediately available, you've got to look at some sort of sulfate source.

Maggie Frazier: There's talk about interactions between nitrogen and sulfur. Should farmers be concerned about this interaction?

Dan Kaiser: Well, one of the things I commonly see and in some of our studies, if we are marginally deficient in nitrogen, we have sulfur studies. Typically, I don't get those real striking sulfur deficiencies because the plant goes nitrogen deficient. That's one of the things that we know there's a linkage between the two. I've done some studies looking at it to see whether or not sulfur changes my optimum [min 00:21:39] rate and that's never been conclusive that that effect is there. It tends to see some bigger impact with the sulfur itself with that.

Dan Kaiser: You can see some ... If you've got nitrogen deficiency, typically you're probably not going to see any impact of the sulfur. Again, we know these two can interact and we can see some things that kind of occur just based on the two. Corn particularly, as Jeff said, ATS, you look at early availability of nutrients, sulfur and nitrogen are going to be two of the big ones that we're going to see problems with in corn-on-corn because of immobilization with those. Having those two together can be some benefit, particularly early on with corn-on-corn to at least get the crop going to get a more even and green stand.

Jeff Vetsch: Dan, I showed those pictures when I used to do presentations around the state of ... We have a 100 percent greater dry matter accumulation and high residue corn-on-corn situations where we put a small band of nitrogen and sulfur near the corn row, and that just really stands out. Now, does that always result in a significantly larger yield increase or a profitable yield increase? No, but certainly when you see that kind of better plant growth and plant health and uniformity, that certainly opens growers' eyes.

Fabian Fernande: Yeah, and with again, a lot of the issues with sulfur that you ... It's really kind of a blurred line there between sufficiency and deficiency. They tend to happen during stressful springs when it's cool, wet. It is pretty difficult sometimes to

tease those apart, because the plants that are stressed, and so you see pale plants.

Fabian Fernande: It's pretty hard sometimes to determine, "Is that nitrogen? Is it sulfur?" That's, again, those are the situations where I would say it's important to start maybe digging a little deeper and seeing, "Okay, is this a real problem with one or two of those nutrients?"

Dan Kaiser: It's one of the things too with a lot of these products. You just see a lot of these products contain both nitrogen and sulfur. I mean, one of the ones we didn't talk about in the last ... Talking about sources, was these micro-essentials lines. I don't know if the efficiency-wise, if it really makes it more efficient for having the two nutrients together, other than, to me, essentially these products are more for the evenness of spread.

Dan Kaiser: You're getting a little bit of sulfur in every granule, so you're spreading out the elemental a little bit better than you would with a product like Tiger 90, so that helps with that. Then, you've got some of that availability. These are mainly just more for ... Suited better just for having a one product that can supply more than one nutrient that you'd only have to look at one product instead of multiples in a blend of a fertilizer itself.

Fabian Fernande: The important thing with products like that where you incorporate different nutrients, MES or MESZ, where you have also zinc, it's like, "Do you really need that?" Those are important things to consider when making those decisions. In my experience, again, going back to the work that I did in Illinois, whenever we had a response to sulfur, it didn't really matter which source we were looking at.

Fabian Fernande: The response was pretty similar across the different sources. Then where there was no response, of course, it didn't matter either, right? Again, as a sulfur source, it can work very well. I think being able to spread it uniformly is probably the biggest advantage. Then if you really need some of the other nutrients that come with it, then it may be a good option as well.

Jeff Vetsch: One thing we haven't talked that much about is rates. I know in some of our early work, we got by in our high organic matter, glacial till soils, with some really low rates, but that's probably the question that I get the most. I see a lot of dealers and a lot of farmers that are applying 20 to 25 pounds of actual sulfur per acre, whether it's an elemental or whether it's a sulfate source. In corn after soybean, I just don't think on our higher organic matter soils, those higher rates are needed.

Jeff Vetsch: Maybe on some of the lower organic matter soils when you get in those eroded knowles and the rolling topography that we see in the plains or in the [maranal

00:25:40] plains of the till and also in Southeast Minnesota. Those higher rates might be justified, especially in corn-on-corn.

Dan Kaiser: Well, even in a corn, soybean rotation, because I haven't really been recommending any application rate ahead of the beans. If you put 20 to 25 pounds on them, yeah, I've seen consistently where you're seeing increases in bean yield on some of those real eroded areas that would be low in sulfur. We don't get some of the issues with vegetative growth, which we typically, with beans it tends to increase vegetative growth, which isn't a good idea for that crop because it tends to take away from seed production.

Dan Kaiser: I mean, that's one of the things with rate. A lot of times what I've been seeing, essentially, currently has been about five pounds, but some of that I've been looking at, and Fabian mentioned this earlier, with sulfur impurities in some of the fertilizers, there's still some in there. I mean, we've been measuring anywhere from 1 to 2% total S in some of the MAP and DAPs in the triple super phosphate sources.

Dan Kaiser: Kind of when I averaged, looked at that, it was about maybe five pounds of total S going on. Which you look at the crop, I actually seems like I can actually see that in some of these sites with that, so that be why we only need to take a low rate. I mean, 10 pounds really goes a long way. Then, if you're banding, I think two to three gallons of ATS really is probably about kind of that sweet spot. Again, it just depends on when you're applying and what source. Because if it's an elemental source, I definitely would go higher than that.

Jeff Vetsch: I agree with you Dan. I think the little bit that's in MAP and DAP and some of those things really makes a difference. Because we see, it's so commonplace today that growers that are in a corn, bean rotation might be putting out 150 or 200 pounds of DAP bi-annually.

Jeff Vetsch: If they're putting that out there right before corn, that's a fair amount of sulfur that they're applying as well. Now, it might not all be available immediately from those sources, but it certainly could be counted even though it isn't on the label. Now obviously, with MES or MESZ, it's right on the label and it's proven.

Maggie Frazier: All right. That 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 UMNNutrientMgmt, where you can also send us your questions for a future podcast episodes. Thanks for listening.