International Ag Labs

Mr. Jon Frank

Teleconference with Mr. Duane Headings

Greenhouse Productivity

Mr. Jon Frank: I want to thank everybody who is on the call with us. This evening we're looking at and hearing about the results that Duane is going to talk about with some greenhouses we're working on. And we're looking at the link between greenhouse productivity and the soil conductivity, fertigations, and foliar sprays.

Duane, can you start off by talking a little bit about these greenhouses? Are they brand new greenhouses, or just a little bit about the two, number one and number two greenhouse?

Mr. Duane Headings: Okay. They're 30 Manatti shakes greenhouses. They were put up not quite a year ago, I believe. And so, they're new greenhouses. They're pretty deluxe. They have cool fills. They have computer controlled ventilation systems. They're nice.

And they started out to raise tomatoes, and that brings up a point. They put these greenhouses on where they used to feed cattle. And a barnyard isn't always the best place to put up a greenhouse, most times it isn't.

So, anyway, they had some problems from day one. They had aphids. They had other problems which included--well, let me think. I don't really know what everything was, but anyway they had some serious issues with the high potassium and all that they were addressing.

Mr. Jon Frank: So, let's just kind of--I want to get a list of lessons learned out of this. I think you just hit the very first one, and that is if you're going to put up a greenhouse, probably avoid old barn barnyards just so that you don't have to deal with the problems of all the excess potassium and what that leads to.

Mr. Duane Headings: Yeah.

Somebody called in and they were having a problem getting on the conference, so that kind of distracted me. Sorry about that.

Mr. Jon Frank: Okay.

Mr. Duane Headings: But, yeah, that's lesson number one. Don't put it on where you fed hogs or calves or anything like that.

Mr. Jon Frank: Okay.

Mr. Duane Headings: And so, they didn't have a crop in the number one greenhouse or in the number two greenhouse. They put in some green beans.

I don't know. They went through some serious issues. And anyway, they called me in January and they had planted the second crop of tomatoes in greenhouse number one. They had planted it in October, I believe, September or October, and this was January 12th.

And so, I went over there and they had tomato plants that were 10 to 12 feet tall. And I would say five to seven tomatoes on a plant, maybe five tomatoes on a plant average. Not setting any flowers, and they just weren't getting any production at all. The leaves were turning brown and they were pinching those off.

And one of the big problems that they had, I believe, is they didn't know where they were or why they were where they were. They didn't know why. So, they--.

Mr. Jon Frank: --Explain that again. They didn't know what? What weren't they knowing?

Mr. Duane Headings: They didn't know why the leaves were turning brown. They didn't know why they didn't have any production.

Mr. Jon Frank: What stage were the tomatoes in when they were not getting production?

Mr. Duane Headings: Well, they no longer--they were no longer setting flowers and they weren't having any small

tomatoes anymore. So, there was just a couple ripe ones and a couple that were green and getting ripe. But, they weren't--.

Mr. Jon Frank: --So, they were in the stage where they should be setting quite a bit of flowers?

Mr. Duane Headings: Yes.

Mr. Jon Frank: Okay. So, they were what? Pretty tall already and--?

Mr. Duane Headings: --Yeah, about 12 foot.

Mr. Jon Frank: Okay.

Mr. Duane Headings: And they just kind of stopped growing at that point.

And so, the first thing I did was take the soil conductivity, measured the energy level in the soil, and that was 120. And on tomatoes of that size, it should be probably at 700 or more.

Mr. Jon Frank: So, you had 120 on the ergs?

Mr. Duane Headings: Yes.

Mr. Jon Frank: Then, in case there's a few people here who don't know what that means, can you just briefly explain what you just did with taking ergs?

Mr. Duane Headings: Taking the ergs. Dr. Reams described ergs, E-R-G-S, as energy released per gram per second, per gram of soil per second. And so, that's a measurement of the energy in the soil that is available for plant growth.

It's a relative number. It's not necessarily an absolute number that it means this and this and this, but it's a relative number that we can go by. If it's low, it's low. If it's high, it's high and so forth. It's not exactly--you don't need 452 or 503, but you need to get your ranges correct.

So, I was measuring the energy in the soil and there was only--we like to have a bottom limit of 200 on ergs, and this was at 120 and plant growth has almost stopped.

Mr. Jon Frank: So, I've read something recently that ergs does not equal plant energy. But, from what you found, at 120 there was no growth.

Mr. Duane Headings: Almost none, and the plant was dying.

Mr. Jon Frank: Plants were dying?

Mr. Duane Headings: They were dying from the bottom up, of course. And the pH was 7.8.

So, pH as Dr. Reams defined it, I find that to be very accurate as a--it tells you the level of resistance to the flow of energy. Above 6.5, you have more resistance. Below 6.5, you have less resistance.

So, we had a energy of 120. We had a pH of 7.8. So, we had high resistance to the energy that was there already, and there wasn't much energy there at all. And so, those plants were basically dying right there.

Mr. Jon Frank: It should also be pointed out that--why don't you tell how--what's the density of those tomatoes?

Mr. Duane Headings: Okay. They're planted in beds--there's two rows per bed. They're planted a foot apart in each row. So, in a two-foot square, there's four plants.

Are you still there?

Mr. Jon Frank: Okay. I was getting some e-mails that were saying they weren't getting on, so I just locked and unlocked. So, maybe I sent everybody off. I don't know.

But, going back, you're talking one tomato plant every foot in the row.

Mr. Duane Headings: And then another row a foot beside it, um-hmm.

Mr. Jon Frank: So, it's a double row of two rows, then?

Mr. Duane Headings: Yeah. A double row with one plant every foot in each row.

Mr. Jon Frank: That's amazing.

And so, then how much walkway is there between the rows?

Mr. Duane Headings: They have fairly wide walkways in that greenhouse. I believe it's over a little over three foot. So, they have wider in that one than a lot of the growers do.

Mr. Jon Frank: And do you offhand know how many tomato plants were in there?

Mr. Duane Headings: Six hundred and twenty-five.

Mr. Jon Frank: Oh, wow, you do know. Wow.

So, the plants were dying, the leaves were turning brown, and the conductivity was 120. And there was virtually no tomatoes. Apparently, there were some. Did you check the brix reading on the few tomatoes being harvested?

Mr. Duane Headings: I didn't, but a friend of mine did and the highest he found was a two.

Mr. Jon Frank: A two?

Mr. Duane Headings: For brix, um-hmm.

Mr. Jon Frank: You know, prior to this, I had never heard of that low of a tomato brix.

Mr. Duane Headings: I hadn't either. I hadn't either.

Mr. Jon Frank: So, what did you do then, or what was the first thing you did when you came to that greenhouse?

Mr. Duane Headings: Well, the first thing I did was take the ergs and then take the pH, and then I started asking questions. And I asked him, "What are you doing?" You know, "Why is it looking like this?", "What are you putting through," and so on and so forth.

And one thing that stuck out to me was that he was putting Epsom salts through, and quite a lot of it. He was putting a quart of Epsom salts through each week. That was 16 ounces, I believe, on Tuesday and then 16 ounces on Friday. And we had brown leaves.

So, he had been doing that for two months, so I knew that that wasn't the problem. If it would have been the problem, it would have fixed it. But, obviously it wasn't fixing it.

And so, right off I knew that the high pH was a problem. We needed to work on that. I knew the energy was the biggest problem. We had to get the ergs up one way or the other.

And so, the first thing we did is just went in with a simple nutrient drench called Inferno, and we put a quart of that through the drip line. And this is basically a thousand square feet wettable area under those drip tapes. And so, we put a quart of Inferno in there. And on the 13th of January (this was the 12th of January), I saw a flower in there.

Mr. Jon Frank: And that was some of the first flowers you saw?

Mr. Duane Headings: Yes, 24 hours later that was the first--yeah, there were no flowers in there, period. None that I found.

Mr. Jon Frank: I'm I'm going to clarify what Inferno is--it's a sulfuric acid based fish with extra acidity, extra sulfuric acid, just a little bit to drop the pH a little lower.

Mr. Duane Headings: And we also put in Perk-Up there at the beginning.

Mr. Jon Frank: Really? So, did you put that in at a separate time, or just the same time?

Mr. Duane Headings: Separate time.

Mr. Jon Frank: Okay.

That Perk-Up is a calcium nitrate based liquid with carbohydrates added. So, it's to supply some available calcium.

Mr. Duane Headings: Um-hmm.

Mr. Jon Frank: And I notice that you started with a pH of--is that 7.8?

Mr. Duane Headings: Yes.

Mr. Jon Frank: So, it's a very high pH.

Mr. Duane Headings: Um-hmm.

And by January 20th, we had the pH down to 6.9, or it came down to 6.9, the ergs was up to 370, and we had approximately 15 flowers on every plant, and the flowers were wide open. And the foliage was greening up and the growth was starting to take off.

Mr. Jon Frank: On the drip tape, is there emitters on each plant then? Just one emitter a hole?

Mr. Duane Headings: They're not exactly placed by every plant. A lot of the drip tape has--well, you can get emitters at 12 inch centers or eight inch centers. Some have them at four inch centers. And I'm not sure what Gary has over there. Twelve or eight, I guess. So, it would be close.

Another thing I should mention is the soil they have is a sandy clay almost, if there's anything like that. It's not

really a loam, but it's almost like a sandy clay and so it percolates very well.

Mr. Jon Frank: It drains good?

Mr. Duane Headings: Yeah. These fertigations went right down in there into the root zone.

Mr. Jon Frank: And did you do any foliar sprays in the first few days?

Mr. Duane Headings: No, we didn't do a foliar spray until the 20th. Started the 12th, and then the 20th we did the first foliar. And we used your Brix Blaster and Enthuse to encourage more flowers. And the first thing we noticed the next day is that we had the ergs up to 370, and it dropped 130 points overnight after we did that foliar.

Now, if it was just because of the foliar or if it was just a coincidence, I'm not sure. But, I am sure that the tomatoes were starting to form. And that's one thing I learned out of this is when the tomatoes start to form, you really have an energy pull right at that point. You can put on flowers, you can maintain ergs, you can maintain growth, but when those tomatoes start to form, those seeds start to form, that energy demand goes up, oh, two-thirds, three or four times as much.

Mr. Jon Frank: I would imagine, then, with the Brix Blaster and Enthuse, it probably stimulated more development of

blossoms and setting seed of fruit and could have dropped the ergs right from that.

Mr. Duane Headings: Yes, I think so, because to develop a seed takes much more energy than to grow a plant. So, that's something you really have watch. When seeds start to develop on a plant, then you need to make sure that you're keeping your energy up.

Mr. Jon Frank: So, it sounds like what you're saying is one of the things that you learned is that based on the physiology of the plant, the level of ergs required in the soil varies.

Mr. Duane Headings: Yes, we did learn that also, definitely. When you're just growing greens, you can do it on a lot less than you can if you're growing fruit. I mean, you could have kale and lettuce and collards in there and it wouldn't take near the energy that it does to grow seeds.

Mr. Jon Frank: Okay.

And would you say that as you go along in a tomato where you are going to grow seeds, but when you start it you may need a different baseline of energy as compared to further on in the tomato production?

Mr. Duane Headings: Absolutely. Once you have your tomato plant hanging full of tomatoes, you need to have your baseline-- I don't have an exact figure, but I sure like to have it 300

points higher on the ergs than just when you're growing your young tomatoes, just as a generalization.

Mr. Jon Frank: So assuming there's no sodium as a problem, so it's not a high sodium soil, would you be comfortable that early growth on tomatoes would be--say 250 ergs would be adequate?

Mr. Duane Headings: It's also depending on the nitrates. But, that would be barely--I'd like to have it 300.

Mr. Jon Frank: Three hundred?

Mr. Duane Headings: Two hundred and fifty would be crowding the bottom, in my mind. A lot of the water that people use to water will have that much ergs. And so, you have to be careful where your ergs is coming from. If your water is 300 on the meter, well, then to grow young plants you're going to need probably a 350 or a little bit more to do it right.

Mr. Jon Frank: So, there's a lot of variables is what you're saying.

Mr. Duane Headings: There’s a huge amount of variables.

Mr. Jon Frank: Okay.

Mr. Duane Headings: If you have put down the dry broadcast before you planted your small tomatoes, then it's not as important because I know then that the foundation is down and that the ergs isn't going to drop as quickly.

And then, yeah, I would agree with you. If you have the broadcast down, you put in young tomatoes and the ergs is 250 and they're doing well, don't worry about it.

Mr. Jon Frank: Well, that's another thing we should point out is that when we started working with the greenhouse, there was no way to put a broadcast down because it was already covered with plastic. So, we had to do just drip work and foliar sprays.

So, then, I believe you pulled the soil sample about that time somewhere.

Mr. Duane Headings: I pulled the soil sample first day.

But, then the soil sample came back probably about the 23rd, something like that, and we were struggling with the energy. These plants were starting to put on tomatoes. And the ergs was down around 200, a little under 200, a little over 200, and we just couldn't get it up.

And so, we started foliar feeding. We were doing one fertigation a day. And so, we stepped that up to two fertigations a day. The 30th of January we started doing two fertigations a day.

Mr. Jon Frank: I see. So, you then--let's go ahead and just kind of describe what is the difference between the two fertigations.

Mr. Duane Headings: Okay. The one fertigation--number one fertigation, we put in growth energy. Primarily, it's micronized limestone and other growth elements. In number two fertigation, we put in reproductive energy. And that is to work those two against each other to create more energy.

That's the point. We were struggling with the energy levels here. We needed to do something different to get that up.

And so, fertigation number one is growth energy package. And the reason we can't run those two together is because sometimes you make cottage cheese or you make cheese or you make mud or you do something that will plug up the drip lines. So, you can't run--for instance, you can't put micronized lime in with 5-1-1 fish--or, I mean--excuse me, the dram fish, the 2-5.2 high phos fish.

I had a farmer put those two together last fall and he--his nurse tank boiled over. It cooked over the top and he lost about 200 gallons of his mix there. So, that's why you can't put those two together. You have to do them separately.

Mr. Jon Frank: So, maybe another lesson out of all this is when you're first starting off, you maybe want to have a good consultant to guide you through some of this. Would you agree with that as a pretty good lesson?

Mr. Duane Headings: Yes, yes. Often, the farmer can't really see what he needs to see. It helps to get outside eyes in or somebody that hasn't been working here every day to come in to take a look at it and pass opinion on it.

Mr. Jon Frank: So, we need some outside eyes and some people seeing it all the time could get some help from a consultant who understands some of the Reams principles.

Mr. Duane Headings: Yes. I sure like to do that on my own. I like to get outside opinions, and it really helps. You need to do it. You really need to do it.

Mr. Jon Frank: I agree.

We got a question here that came in. How does sodium affect the ergs requirements? So, let's say that instead of having low sodium, what if it was higher sodium in the greenhouse? What would we be doing for the ergs, for the base levels?

Mr. Duane Headings: Well, what sodium does is pushes the number higher on the meter. In the language that us farmers can understand or produce growers can understand, it pushes the number higher on the meter and does nothing for the plant.

Now, one of my sayings is never say never and never say always. So, when I say something, "It does nothing for the plant," sometimes it might do something for the plant. But, for

all practical purposes, it's not helping us by putting a higher number on the meter.

Therefore, it's very important to know what that sodium level is so you know if I go--for instance, I'd have gone into this greenhouse, plants are at 12 feet tall. They're dying off at the bottom. No tomatoes, no flowers, the bumblebees can't live in there because there's no flowers to pollinate and whatever, and that ergs reading would have come up 450. I would have known that there is something in there that's pushing the number high on the meter that is not contributing to the plant's health.

And so, you do have to take that into consideration. I would have done the same thing. I would have established a baseline. "Okay, I've got a reading of 450 and nothing's happening." That means we have to go up. There's only one way to go.

Sodium can help. Well, you know, it can help the taste, but it's a minor--and the other big lesson I got out of this is--and this one is a really big lesson. You have to realize that all growth, all formation of matter, is the creation of new cells. That sounds simple in the extreme, but if you're not creating more fruit, if you don't have growth, you're not forming new cells.

Okay, so what about it? Well, this is what about it. Nitrogen is the number one element it takes to form a new cell. So, if you're not forming new cells, you probably have a nitrogen problem. Not probably, you have a nitrogen problem. I'm not saying that in every time you're going to be low, but I'm going to say you're going to have a nitrogen problem.

That was a huge lesson for me. Anytime you look at any plant and it's not growing, then you don't have new cell formation. And you need to think about that and really think about that because then you start to see this picture that you have to create new cells and then you need to know how to create new cells.

And that's where you guys up at the International Ag Labs helped me so much to understand what elements it takes to form new cells. Then, you can start putting in what you need and go from there. It's all about life at the cellular level. Maybe I'm getting a little bit ahead, but I sure wanted to bring that out.

Mr. Jon Frank: Well, I wrote it down because I've got a whole list of lessons learned. And I've already got six of them so far.

Mr. Duane Headings: That's the most important one that I saw out of this whole thing.

Now, back to that sodium issue. So, if you have 450 on the ergs and you're still not making new cells, then the energy that that meter is registering is not usable by the plant to create new cells. So, we have to go on top of that with the correct elements to start forming more new cells.

Mr. Jon Frank: So, that can come from sodium as well as high conductivity water?

Mr. Duane Headings: It can, and it can come from nitrates. And nitrates in and of itself, they'll push a plant growth if you have potassium there. But, sometimes--and I learned this lesson last year. I had a grower with high nitrates in his water. It really didn't push huge, lush plant growth like you'd expect from a high nitrogen situation, but it pushed the ergs extremely high in his soil in the greenhouse.

Mr. Jon Frank: And it didn't grow very well?

Mr. Duane Headings: Not very well. He got a crop but it wasn't a very good one. It was a struggle. And so, he had his water tested and now he found out that there's high nitrates. So, now it all falls together. That's why we were getting high ergs readings and the plants weren't doing very well.

So, in that greenhouse, we had to establish a baseline on the meter of about 800. When it came down to 700, 600, we had to start fertilizing or the plants just stopped.

Mr. Jon Frank: Okay.

So, now would you say that this is why it's critically important to get a soil test, and so you know your baseline on your sodium and some of the other elements like the nitrogen and phosphorus, potassium, calcium? Those are some really key things.

Mr. Duane Headings: Exactly. Without a good soil test, you're still out there hunting for mosquitoes in the dark of the moon with a blindfold over your eyes with a flyswatter.

Mr. Jon Frank: Well, where I come from, northern Minnesota, you just go outside and they got you.

Mr. Duane Headings: Well, I mean, trying to hit one with a flyswatter. Maybe they're so thick you could just take a swipe at it and you could--.

Mr. Jon Frank: --What you do is you cover your mouth so you don't breath them in.

Mr. Duane Headings: Okay. Well, that's wasn't a good analogy.

But, anyway, you're lost without a good soil test because there's no way to know your sodium levels, your nitrates levels, your potassium levels, your phosphorus levels. All of those play into that ergs thing. They really do.

Mr. Jon Frank: So, in other words, how you manipulate the conductivity, what ingredients you use, you go back to the soil

test to determine where the weak points are and try to hit those as well as bringing the ergs up.

Mr. Duane Headings: Absolutely.

Mr. Jon Frank: Okay.

Mr. Duane Headings: Because if you try to push the ergs--say you have high potassium and high nitrates to start with. And if you go in there with a high nitrate, high potassium product, you will probably push the ergs up some, but the health of the plant will simply go down very fast if you put on what is there in excess already. That is one good way to bring the health of the plant down.

Mr. Jon Frank: Okay.

So, let's carry forward the story now. We started having some initial success. You saw blossoms and then you started struggling as the tomato plant was filling with new tomatoes. You were struggling with the ergs.

What were you doing then to try to overcome that?

Mr. Duane Headings: Well, when we got the soil test back, we were looking at a calcium level of around a thousand. We were looking at nitrates around 40. Ammonia, I believe, was at four. Potassium and phosphorus were both a little high, 400, 500, 600, something like that.

And so, we thought, "Okay, what can we do? We really don't want to add nitrates," which I did a little bit of that

initially. "We really don't want to add potassium or phosphorus. We're very short on calcium and we're very short on ammonium nitrogen, ammoniacal nitrogen, ammonia nitrogen."

So, the first thing we did is starting adding micronized lime through the drip line. And that supplies calcium when it solubilizes, but to solubilize that you have to have microbes. You have to have sugars. You have to have life there in the soil. And to have life in the soil, you have to have ergs in the soil. And lime by itself does not raise the ergs a whole lot, and it didn't. So, we needed something to play against that lime so we could raise the ergs more.

And of course we started foliar feeding at the same time. And so, we went in there with some ammonium sulfate, which is ammonia, nitrogen, and sulfates. And the sulfates are acidic, so they bring the pH down. And so, we started bouncing that off the lime, so to speak, or working it against the lime. We fertigated the lime in the morning and the bugs and the sugar and so on. And then, and in the evening, we would put in ammonium sulfate. We put in a little bit of phosphorus even.

The test was actually--oh, I don't have the most recent test here. Well, this is the most recent. I don't have the--.

Mr. Jon Frank: --I have the first one, Duane.

Mr. Duane Headings: What's the first one on phosphorus?

Mr. Jon Frank: It was 421 and then potassium was 377.

Mr. Duane Headings: Okay. On the first one?

Mr. Jon Frank: Yep.

Mr. Duane Headings: So, we had 421 on phosphorus. So, we went ahead and added a little bit anyhow just to try get the ergs up because we needed something soluble to get the ergs up.

Mr. Jon Frank: You know, one of the things we may want to point out, when you're having such a high level of density of tomato plants and they're 10 foot tall and--some of the rules of, you know, only maybe 200 pounds of phosphorus and potassium, that is such a little buffering that in greenhouses that are this intense--.

Mr. Duane Headings: --I shouldn't have called that high--.

Mr. Jon Frank: --It should be a little higher.

Mr. Duane Headings: Yeah.

Whoops. Did you hear that?

Mr. Jon Frank: Okay. I'm still here. You're there, so--are you there, Duane?

Mr. Duane Headings: Hello?

Mr. Jon Frank: Okay. Duane, can you hear me?

Mr. Duane Headings: Are you there, Jon?

Mr. Jon Frank: I can hear you. Can you hear me? Duane?

Okay, it looks like Duane got cut off. I'm going to look at a couple questions here. Roger had a question on what is the brix of the tomatoes now. And we're going to cover that.

But we're--we started with two brix tomatoes, which is the lowest I've ever heard of a tomato. And then, through the course of time, it moved up to two to four brix.

Mr. Duane Headings: --I'm going to wait a little bit and see if Jon comes back on.

Mr. Jon Frank: I'm back--I'm here, Duane. Can anybody hear me? If you can, could somebody e-mail me at Soil Restorer? Okay, thank you, Michael. I'm glad you sent me the e-mail. Somebody can hear me.

Okay, I'm going to keep on talking a little bit and going to cover some of the questions.

Thanks, David. I got your message.

Duane, are you there? Okay.

Mr. Duane Headings: Yeah, I'm here.

Mr. Jon Frank: Oh, you're back. Hey, great.

Mr. Duane Headings: Yep. Just called in.

Mr. Jon Frank: I don't know what happened, but--okay. Somebody want to e-mail if you can hear both Duane and I? Everybody can hear--seemed like they can hear me.

Mr. Duane Headings: Okay. I had a call or two. People could hear me and they could hear you, but we couldn't hear each other.

Mr. Jon Frank: Yeah. I could hear you, but you couldn't hear me.

Mr. Duane Headings: No, I couldn't hear a thing. So--.

Mr. Jon Frank: --Okay--.

Mr. Duane Headings: --I just got off at the end.

Mr. Jon Frank: All right.

So, you were talking about--I can't even remember what you were talking about now.

Mr. Duane Headings: Okay. We started talking about what we started adding in and why we started adding it in.

Mr. Jon Frank: Okay, what you were doing to get the conductivity up.

Mr. Duane Headings: And I don't know how detailed you want to be, but basically what we did was pushed the--okay, we need to say that nitrate nitrogen pushes growth. Ammonia nitrogen produces seeds. We did not need more growth. We needed more seed. We needed more fruit.

And so, we started putting ammonium sulfate in there. **Mr. Jon Frank:** Okay, so you took all nitrates out?

Mr. Duane Headings: Yes, all.

Mr. Jon Frank: Okay. That's an important thing.

Mr. Duane Headings: Um-hmm. All nitrates, because we had sufficient growth.

Mr. Jon Frank: Okay.

Mr. Duane Headings: And so, we put 5-1-1 fish in there.

Mr. Jon Frank: Okay.

Mr. Duane Headings: And describe what that is, Jon.

Mr. Jon Frank: That's an ocean fish that is--they take the oil out and then they leave the meat on. And it's basically cooked and ground real fine, and then it's basically dehydrated down to a pretty low level of moisture so it's about 50 percent solids. It's got sulfuric acid so there's a lot of trace minerals. And so, the meat then of course makes the nitrogen high as a 5-1-1. So, it's a excellent fish for high nitrogen, and an amino acid form of nitrogen, too.

Mr. Duane Headings: Yes. It's not just hard chemical nitrogen.

And that is actually when we started seeing the ergs come up and stabilize. They crept up to 400, 450, 425, then on up to 460 and then to 500.

Mr. Jon Frank: Did you say then you were using both ammonium sulfate and fish?

Mr. Duane Headings: Both.

Mr. Jon Frank: Really?

What quantities were you using?

Mr. Duane Headings: We used a quart of 5-1-1 fish and we used 16 ounces of ammonium sulfate.

Mr. Jon Frank: For that greenhouse?

Mr. Duane Headings: Every day in the PM. In the AM, we were putting on the limestone and the bugs and the sugar and the

liquid humates and so on. And in the PM, we were putting on the reproductive growth.

Mr. Jon Frank: And I might add that we still had the sugar and some--another bug package in the second fertigation.

Mr. Duane Headings: Yes, and--.

Mr. Jon Frank: --And some humates--.

Mr. Duane Headings: --We don't want to overemphasize one thing or the other. Without the bugs, without the sugar, without the humates, I don't think this would have worked. We're kind of hitting the high points and saying, "Okay, we needed nitrogen," and that is a high point and it's a very important one. But, I'm glad you brought that out. Without sugar and without bugs, it doesn't work either, or not nearly as good.

Mr. Jon Frank: Okay.

And in the second fertigation, were you also putting micronized Ream-In, a broad-spectrum rock powder, or not at this point?

Mr. Duane Headings: Yes.

Mr. Jon Frank: Okay, then I'll describe that, too, because it's just one of the things that we were doing. Micronized Ream-In is a broad spectrum finely ground rock powder. And it'd be kind of in the same family--similar to Azomite, if people know what that is. So, that was going in.

What rates were you using that in?

Mr. Duane Headings: I believe that was two tablespoons.

Mr. Jon Frank: Okay.

And how much micronized limestone were you putting in?

Mr. Duane Headings: We started out with two tablespoons--no, two teaspoons. We started out with two teaspoons, and that is 0.4 of an ounce.

Today, we're putting in four tablespoons of micronized lime just to try to--and now the issue is with all the sulfates and with everything going in and probably the bugs in the soil starting to work very well, the pH dropped from--we started at 7.8 and now it's running down around five.

Mr. Jon Frank: Okay.

Mr. Duane Headings: And so, we've bumped up the calcium to try to bring the pH back up to create more resistance, and therefore we gain more energy.

Mr. Jon Frank: Okay.

I think what I hear you saying is another lesson, that intensive production in a greenhouse requires intensive monitoring. Would you agree?

Mr. Duane Headings: Absolutely.

Mr. Jon Frank: And so, you're monitoring how frequently?

Mr. Duane Headings: Daily.

Mr. Jon Frank: And what were you checking every day?

Mr. Duane Headings: We were checking the ergs, the pH, and the ORP every day.

Now, the ORP, you can explain that, Jon, if you want to. With this program, it seems that if you keep the ergs where it needs to be, if you put in what needs to be put in, the ORP kind of takes care of itself.

Mr. Jon Frank: I would agree that from what we're seeing, that we don't really need to monitor the ORP. But, we were experimenting. We thought maybe because it's under plastic it might need it. Our conclusion at this point is it's not a big issue at this point. Better to go with the pH and the ergs, and if we just follow that based on what we see with the soil tests, we're probably going to be okay.

Okay. So, you're monitoring every day.

That's a huge lesson. I mean, people don't think necessarily that they need to monitor that every day.

Mr. Duane Headings: And you don't have to. You don't have to, but then your production will not be--you get out of it what you put into it. That's the thing.

And this was a very difficult situation to jump in there right in the middle where there wasn't anything happening and you had these plants that were 12 foot tall. It was almost like having a fleet of racecars all ready to go and you brought a 55 gallon drum of gasoline in the back of your truck to fuel them

all up. You couldn't keep up hauling fuel. That's was about what it was like.

Mr. Jon Frank: Hmm.

Do you realize a quart per day is 10 gallons an acre daily on liquid fish? Are you really sure you needed that much? I'm quizzing you. I'm taking the other side here. Just curious.

Mr. Duane Headings: Well, all I can say is it's working. That's what I can say.

The brix in the leaves--on January 12th, the brix in the leaves were around four, four to five.

Mr. Jon Frank: Okay.

I mentioned in an e-mail six. So, I was wrong. So, four to five was the brix of the leaves.

Mr. Duane Headings: It was hard--yeah, they were struggling to keep it at that level. That's the way I understood them, anyway.

And by February 28th, the brix in the leaf was up to 11. So, I'm not going to argue.

Mr. Jon Frank: Okay.

So, the results are speaking for themselves. Chart now what we've got with tomato brix, starting with the very beginning ones and then where we're at now. Bring it up to now.

Mr. Duane Headings: The brix to start with was two and under. Two was about the highest they could find. And now, we

tested one here at home that was 6.1, and that's the highest one I tested. It's what we have now. And I picked the little bitty ones that don't sell. And it's interesting. Those little things that get kicked aside because they don't look as pretty don't taste as good, either.

Mr. Jon Frank: Really?

Mr. Duane Headings: They are the tail enders.

Mr. Jon Frank: Really?

Mr. Duane Headings: There's a reason why a number one tomato is called a number one tomato.

Mr. Jon Frank: Hmm.

Have you checked, now, the larger size tomato to see just what the brix is on those recently?

Mr. Duane Headings: Yes. Yes. Gary gave me a yellow one just recently, a large, nice one. It's off of one of the yellows there at the backend of the greenhouse, and that I believe it was 6.1.

Mr. Jon Frank: But, it tasted better than the smaller ones that were--?

Mr. Duane Headings: --Oh, yeah, 4.9. Yeah. You can taste the difference from 4.9 to 6.1.

Mr. Jon Frank: Oh, so you had a 4.9 on some of the smaller ones?

Mr. Duane Headings: Um-hmm.

Mr. Jon Frank: Okay.

And the bigger ones were six?

Mr. Duane Headings: Yes.

Mr. Jon Frank: Interesting.

Mr. Duane Headings: And so, we kept on doing that. And well, then we got hit with an ice storm. What was it, the end of February? Let's see. No, let me see. When did we have the meeting up there in Branson?

Mr. Jon Frank: February 20-something. Twenty-fifth, sixth, seventh? And we--.

Mr. Duane Headings: --So, we had a--.

Mr. Jon Frank: --And I saw the greenhouse on the 24th.

Mr. Duane Headings: We got hit with an ice storm about the 6th and 7th, somewhere in that area, of February. And the electricity went off. It went down to 39 degrees in there. And so, we had a huge setback as far as yield. The flowers aborted because of the cold temperature, I guess. And it took us almost three weeks, a little over two weeks, to get the flowers opening back up nice and wide and yellow. It took almost three weeks to get it going again real good.

So, right now, we are harvesting that slump. Right now, the harvest isn't too great because of that ice storm in February. But, in the 18th of March, the pH was going down a

little under five. And that's where you brought up the idea of putting in some milk.

And so, we starting putting in some milk and the pH did come up. It came up to 5.3, 5.7, 5.0, 5.1. And what we saw by putting in that milk was that the tomatoes sized more rapidly and the brix in the leaves came up further. And now, we have a 15 brix in the leaf.

And actually, Jon, we're right in that harvesting slump, so I don't really have a nice, big, red tomato brix right now. There's some that's ripening.

Mr. Jon Frank: So, you're harvesting the tomatoes that were put on during that slump and the time that they were behind.

Mr. Duane Headings: Yes.

Mr. Jon Frank: I got a question here I just want to cover. David was curious about the phosphates on the greenhouse number one that we're talking about. On January 20th, which is--Duane must have taken this, oh, maybe the 12th or 14th or somewhere around there.

Mr. Duane Headings: Twelfth, I think.

Mr. Jon Frank: --12th, okay. We had 421 pounds of phosphates and 377 pounds of potassium and 1,000 pounds of calcium, 1,063. And then, fast forward--and do you want me to just give the numbers for the next soil test, Duane?

Mr. Duane Headings: Sure.

Mr. Jon Frank: Okay. In our lab, we got it on the 20th of March, so it must have been pulled a little bit before that. And the phosphorus has dropped to 257, and the potassium dropped to 200. And the calcium dropped a whopping big loss down to 542.

Mr. Duane Headings: So, the phosphorus--.

Mr. Jon Frank: --And the--.

Mr. Duane Headings: --And potassium both dropped 200 points, right, approximately?

Mr. Jon Frank: Basically, yes. Hundred and seventy-seven on the potassium. But, the calcium went from 1,000 to 500. So, it dropped significantly. And the pH is down to a 6.1.

Mr. Duane Headings: Actually, we're getting lower readings than that in the greenhouse.

Mr. Jon Frank: You're getting lower readings, yeah.

Mr. Jon Frank: I wonder if sitting in that and going through the lab and stuff maybe without roots pulling on it, maybe it had a tendency to kind of come back up a little bit, you know what I'm saying?

I don't know that, but I'm just speculating out loud.

So, we had a big drop. But, in the meantime we're seeing quite a bit of production from the very first test in--basically it's two months--on our soil test, it's two months to the day.

We had nothing, then we had quite a bit of production after we had a bunch of blossoms put on, and now we're going through a little bit of a lull because of that cold spell that went through the greenhouse.

Mr. Duane Headings: We had an ice storm and the electricity went off so the heat went off.

But, I was in there today and there's now--the first big clusters that came on after the ice storm are ripening now. And there's four clusters above that, five total, average on every plant. And they're just loaded. They're really loaded and they're sizing fast. So, it looks good. It looks like the production will jump way back up again.

Mr. Jon Frank: Okay.

So, what is the production? On a 3,000 square foot, what are you seeing before that was slowed down because of the ice storm consequences?

Mr. Duane Headings: They take 500 pounds out of there in a week.

Mr. Jon Frank: Five hundred pounds?

Mr. Duane Headings: Um-hmm.

Mr. Jon Frank: Okay.

Mr. Duane Headings: What I mean--that's not so big. You growers that harvest more than that and you're thinking, "Oh, that's not that much."

But, what we have to remember here is we have a plant that was almost dead, that the brix on the leaf was four, that the brix on the fruit was two, and they weren't doing anything. And now, to pick it up that much, those plants have the ability to do that much just by increasing the energy with the correct nutrients based on the soil test, I think it's phenomenal. And I think they will see higher yields than that if they--you know, if they keep on doing this thing and pushing these plants. It looks good in there.

Mr. Jon Frank: Okay.

I want to clean up just a couple questions here. Is the 5-1-1 fish levels okay with organic certification?

The fish itself is fine for organic certification. I don't know if they say how much nitrogen can be applied per area. If they do, I'm sure we're way over. But, the soil required it and the density of the plants required it in order to keep the energy up.

So, you'd have to check with certification. But, if that was not kept up, I'm very positive that the ergs would have really gone down. The plants would not have been able to add on new clusters of blossoms and the leaves, the brix of the leaves, would definitely have gone down because the energy has not been kept up.

Next question, were you measuring the soil or the plant pHs and ergs?

We were doing everything with the soil. We were not measuring leaf pH or energy. And maybe you did, but it wasn't showing up on your sheets here that you keep records of.

Mr. Duane Headings: No.

Mr. Jon Frank: Okay.

And so, this leads up to one other thing I just mentioned, keeping records. One of the most important things to do when you're going through this whole process is keep a detailed sheet of records of what was there, so Duane and Gary, you have date, time, the ERGS, the pH. They have ORP but I think we can skip that, and then what was applied. And do this every day and--so that you'll go back and be able to learn a whole lot just by watching what was done in the past.

Would you agree with that, Duane?

Mr. Duane Headings: Absolutely. Records are extremely valuable as an educational tool. Extremely so.

Mr. Jon Frank: Yes, very.

Mr. Duane Headings: The other thing I want to mention is I don't want anybody to jump on that micronized lime thing and run with it. We're putting on the equivalent now of 10 pounds per acre per day, the equivalent. That is not something you want to try in strawberries or in other plants.

Tomatoes planted this density obviously will handle that and they'll thrive on it. But, be careful and don't take that and just run with it and put it on anything. I wanted to bring that up.

Mr. Jon Frank: Yes. This is intensive production on a low calcium soil. And we're watching the soil test as well. So, you got a good warning.

Mr. Duane Headings: Another thing. If you start out with a soil that has 3,000 calcium, it will not take near as much additives, so to speak, or so much in the drip line to bring the ergs up.

I like the example of bouncing a golf ball off of a snow bank or off of a white cement wall. If you have a good foundation of calcium, you're bouncing the golf ball off of a cement wall. It'll come back and hit you hard. If you try to bounce a golf ball off of a snow bank, it'll go right in there and it'll disappear and you won't see it.

And that is why in a high calcium situation, the foliar feeds will do a lot more, the nutrient drenches will do a lot more, everything will come back and hit you a lot harder. It won't take near as much as in this situation. And that makes it a lot easier and a lot cheaper.

Mr. Jon Frank: Okay.

Duane, can you cover the foliar spraying? What you started with, what you ended up with, what you're doing now? And I am actually doing to set the phone down and I'll be back in one minute while you cover on foliar spraying.

And if you need to take a break afterwards, just let me know, okay?

Mr. Duane Headings: I get the point.

Mr. Jon Frank: Okay. So, just cover what you did from the beginning and all the way up to what you're doing now. And then, when I come back in, I want to hear if there's any lessons learned. I want to get that and write those down, okay?

Mr. Duane Headings: Okay.

What we started out with was foliar spraying with Brix Blaster to put more blossoms on. We didn't have blossoms. We needed blossoms. We needed more fruit. Brix Blaster is a spray. It is a foliar spray that Jon has that really puts on blossoms. It really does.

And this sounds kind of goofy, but if Brix Blaster does not put on blossoms, you've got another problem. What I'm saying is never say never and never say always. Just after that ice storm, just after that 39 degrees in that greenhouse, just after that, Brix Blaster didn't work too well. Why not? Because the plants were extremely stressed from the cold temperatures. And so, you have to take everything into account.

Anyway, we sprayed with Brix Blaster and we came on down through there. And it works good. And then, there's another product that's called Enthuse, and that works very well for plant stress. It's an excellent product to bring the brix up in the plant and in the fruit.

And we have seen the brix in the leaves go from--well, they were at four and then they went up to 11. And now, he's foliar spraying with Enthuse and we're getting the milk in there, and the brix in the leaf is actually up to 15 right now. And--.

Mr. Jon Frank: --Okay, Duane, I'm back. Just keep going.

Mr. Duane Headings: Okay.

The big lesson that we got out of this was when he started foliar spraying with the Brix Blaster, he said, "Duane, this stuff doesn't work." I said, "Oh? Well, what's the problem?" "Well, it burns. And I was checking the brix in a leaf, and it doesn’t really go up."

The big lesson is don't put it on too thick. Do not put it on too thick. And there, we come back to the sodium issue or the high ergs issue, high nitrates. If the ergs is very high, say 2,000 or 1,500 even, then the foliar sprays will burn the plant more readily.

Now, how much should you put on? Well, how big are your plants? What are you using? What water are you using? There's a lot of questions like that. In my opinion, you should always

use distilled water or rainwater or pond water for foliar feeding,

Mr. Jon Frank: What about reverse osmosis water?

Mr. Duane Headings: I have used that a little bit, but I prefer distilled. It just seems that it works better. It brings a better plant response. The big thing is make sure that the ergs in your water is under 50 that you use to foliar spray. That's the big thing.

And so, back to the amounts. In this 30 by 96 with 600 big plants in there, we're using slightly less than half a gallon, around half a gallon of liquid, to foliar spray that greenhouse and that's enough. And if you're going to do it more than once a day, cut the rate in half as far as the concentrate going into the water.

Mr. Jon Frank: Okay.

I think what you said then is even if you've got a recommendation, you have to be looking at the plants and cut it back if needed.

Mr. Duane Headings: Yes.

You need to use your head for something else besides a hat rack.

Mr. Jon Frank: Okay.

Mr. Duane Headings: You need to watch the plants and if something--I just had a call this morning from a greenhouse

grower. And he said, "Duane, one of the foliar sprays, it's not working. It doesn't work." I spray it on the plants--and this is small plants that he's starting. He said, "I spray it on the plants and they just droop down. It looks like they're going to die. It doesn't work. What should I do?"

I said, "Well, can you see on the leaf that you sprayed it?" He said, "Oh, yeah. Yeah, we get it on there." I said, "Well, you're putting on too much. You're putting on too much. Use way, way, way less. You need to have the finest mist possible. Just let it drift down on the leaves. I like to hold the nozzle at least two foot away from the leaves and just let it drift lightly down onto the leaves. You should not be able to see much moisture at all on that leaf."

Mr. Jon Frank: In other words, you're almost making a dew and letting it just kind of come to the plant that way. Not a dew, a fog.

Mr. Duane Headings: Well, what you want to do is just increase the mineral content in the air. That's the bottom line, really.

But, yeah, atomize it as fine as you can and just let it drift. Just a fog. That's excellent. And then, the hairs on the plant can pick that up out of the air just fine. And don't wet the leaf down with foliar sprays that are not intended to wet the leaf or you'll have burning issues and so on.

Mr. Jon Frank: Okay.

So, you primarily used Brix Blaster and Enthuse?

Mr. Duane Headings: Yes.

Mr. Jon Frank: And you used them separately or together?

Mr. Duane Headings: Separately.

Mr. Jon Frank: Okay.

Brix Blaster is a foliar spray that promotes blossoms. It feeds the plant NPK calcium, but it is a strong energy to reproduce.

Enthuse is a broad-spectrum trace mineral foliar spray that we've added quite a bit of trace minerals. It also includes some PGRs, some single amino acids, and I spike it with some of the things I know we need such as selenium and iodine in very dilute quantities to make sure we're bringing that up.

Mr. Duane Headings: In my language, Enthuse is a vitamin B shot to the human. I don't know if there's any of that in there, but that's a good way to put it for the growers. It's just like a nutrient shot for the plant.

Mr. Duane Headings: And I was telling them, Jon, that just after the ice storm, the Brix Blaster didn't work very well at opening flowers. So, never say never and never say always. But, generally speaking, Brix Blaster does a wonderful job at making a plant bloom.

Mr. Jon Frank: Right.

And did--so you felt like the Enthuse did a good job there, though, of helping it through plant stress?

Mr. Duane Headings: Big time. Yes, very much.

Mr. Jon Frank: Okay.

Any lessons else besides what I've got that Brix Blaster or any foliar sprays will not work if they're too concentrated, so be willing to cut back the concentration, reduce the amounts, make fine mist.

The other thing is we've found that distilled water works really good for foliar sprays, otherwise pond water, collected rainwater, try to keep it under 50 ergs.

Any other lessons that are real takeaway lessons?

Mr. Duane Headings: One thing I would like to mention is in the backpack sprayers, a lot of us use Solos. And I just found out that the SP systems, it's SP on the back of the sprayer, will build up to 150 psi. They have a more durable tip that can produce a finer mist and it does a lot better job. As far as a backpack pump up sprayer, I prefer the SP over the Solo now. I thought the Solo was the best, so that's what I had.

Mr. Jon Frank: So, the SP, is that a brand?

Mr. Duane Headings: Yes, I guess. It's SP Systems right on the back of that backpack blower. And where I find it is Ben Meadows or Forestry Supply or, you know, one of those companies. They sell it. I'm not sure if Gempler's sells SP or not.

Mr. Jon Frank: You're saying that SP will have a higher velocity of spray and probably finer mist, Duane?

Mr. Duane Headings: It will have a finer mist, definitely. Definitely will because it has a higher psi, higher pressure. They use a different pump. It's a diaphragm with a piston in it. A diaphragm pump generally goes to 60 psi, and the piston pumps generally go to 90.

The way they describe it in the ad is that they have a diaphragm with a piston in it. So, we can still do the powders and so on through the backpack because, with a diaphragm pump, the powders don't get down into the piston. So, that works great.

But, this one goes to 150 psi. I was just looking at that today. And my friend Jason has an SP and I am sure that that will atomize it finer, will put out a finer fog, than my Solo backpack.

Mr. Jon Frank: Okay.

Now, these SP sprayers, you're just hand pumping, though, is that right?

Mr. Duane Headings: That's right. It's a hand pump, goes on your back, three, four gallon.

Mr. Jon Frank: Wow. And still can get up to 150 psi?

Mr. Duane Headings: Yes.

Mr. Jon Frank: Wow.

Mr. Duane Headings: That's what the ad said. I'm going to buy one.

Mr. Jon Frank: What kind of a tip is on there?

Mr. Duane Headings: It's a brass or a copper tip. And it's adjustable. You just turn it for a fog or screw it out for a stream.

Mr. Jon Frank: So, the tip that comes with the SP sprayer would be fine?

Mr. Duane Headings: Yeah. Um-hmm.

Mr. Jon Frank: Okay.

Mr. Duane Headings: And see, the Solo just has a plastic. So, I'm thinking I'm glad I saw that because that's what I'm going to get now.

Mr. Jon Frank: Well, excellent.

So, you've basically, through the course of beginning the program, you started with some foliar sprays and you increased the frequency. I imagine you covered that. Is that right?

Mr. Duane Headings: Well, that's correct, but no, I didn't cover that very well.

To start with, I was more concerned about getting the ergs up in the soil because I knew that with low ergs, foliar feeding--here we go again. Never say never and never say always. But, with low ergs, foliar feeding is generally a waste of time. But, then again, it's not a waste of time because the

foliar feeding that you put on the plant goes down through the plant and into the roots and helps to build up the soil. But, it's not a good way to build up the soil because it's very slow, very difficult, very expensive.

So, foliar feeding when the ergs is that low generally does not bring visible return very fast at all. So, when the ergs came up, say, to 400, 450, 500, we started increasing the frequency of the foliar sprays and then you could see more response also.

Mr. Jon Frank: Interesting.

Mr. Duane Headings: So, now we're foliar spraying every day in this one.

Mr. Jon Frank: You're foliar spraying every day? And that's one time per day?

Mr. Duane Headings: One time, yeah.

Mr. Jon Frank: Okay.

Mr. Duane Headings: I don't know, he might occasionally do it twice. But, basically we're aiming at once a day foliar spray, and the flowers are opening very nicely. The clusters are forming good.

Another thing I want to point out is cracks. Everybody that grows tomatoes knows what cracks is in tomatoes. And when the ergs was that low before January 12th, they had 50 percent or more cracked tomatoes. And two weeks ago, we figured up what

the percentage was and it was down to 15 percent. I don't know if it will improve that dramatically in other situations or not, but it was a huge improvement just by bringing the ergs up.

Now, Jon, you explain that. We're sizing faster, we're growing faster, but it's not splitting as bad. Now, what do you think of that?

Mr. Jon Frank: Okay. I'm going to theorize something but I don't know if this is true. I'm going to look at the soil test to see. Maybe that'll back me up.

But, one of the things is we are putting the Ream-In, which is a broad spectrum trace mineral, and we're putting fish, which is a broad spectrum trace mineral from the oceans. And we're putting Enthuse, which is a broad-spectrum foliar spray. And in all that, we're adding a certain amount of copper. And copper helps the plant to have the barks to stretch so, you know, it can help to prevent splits.

Were you putting any--specifically any chelated copper in here?

Mr. Duane Headings: We did once or twice.

Mr. Jon Frank: Okay. So, not frequently, though?

Mr. Duane Headings: But, not frequently because on the soil test the copper is showing high.

Mr. Jon Frank: Okay.

And I'm going to tell, when we began in January, the copper was showing 3.3. But, when we looked in March, it's showing 4.6 parts per million.

Mr. Duane Headings: So, we put in enough.

Mr. Jon Frank: So, we've seen some increase here.

And it's my recommendation that tomato ground, you want to have it in the upper threes to up to five parts per million on copper because you want to prevent the cracks and the splits.

And when I listened to Dr. Reams on some tapes, and his idea was when you got splits on tomatoes, check the copper and you're probably going to need to add some.

Mr. Duane Headings: I got another lesson here. Don't leave the water on overnight.

Mr. Jon Frank: Okay. Big lesson.

Mr. Duane Headings: He had six inches of water in that greenhouse. And the ergs were up around 600, staying up there. Six hundred, 650, 580. And then, he--and we all make mistakes but, anyway, he forgot the water and he left it on overnight. And it dropped down 450, then 400, then 350.

And we immediately started putting in more products, more of the different things, you know, and adding I added in some more potassium. I added in a little phosphorus. And then, today it's back up to 650, so we got over that one okay.

Mr. Jon Frank: So, what's your goal right now? As you look at the tomatoes and the blossoms and the brix of the leaves, what's your goal for ergs as you're trying to stabilize at this point where you're producing heavily, you have a lot of tomatoes that you're filling, plus you're still putting on new blossoms?

Mr. Duane Headings: Right now, with this guy's water, which his water has 170 or 200 ergs, something like that, my goal is 700 in this greenhouse.

Mr. Jon Frank: Okay. So, you would like to keep it around 700?

Mr. Duane Headings: Yes.

Mr. Jon Frank: Okay.

Mr. Duane Headings: That's with water at around 200. Um-hmm. And they do very nicely there.

Mr. Jon Frank: Okay.

So, just a couple things that I recall. If you kind of monitor the brix reading of the leaves, if you see a sudden drop, what's that mean to you?

Mr. Duane Headings: Well, you messed up somewhere. Okay, you said if you see a sudden drop in the brix--.

Mr. Jon Frank: Let's say you're at 11 brix and you suddenly went down to 600. Sorry. Excuse me, 11 to 6.

Mr. Duane Headings: If you're monitoring your ergs, you'll probably see it in the ergs as quickly as you'll see it in the leaf or a little quicker. There's any number of situations that could cause that.

But, what that means is that the plant is no longer making new cells at the rate that you want it to make new cells or it's not producing healthy cells because the leaf is the sugar factory for the plant. That's where it synthesizes its proteins.

And so, you have to go back and you say, "Okay, the brix in the leaf is dropping. That means the sugars in the leaf is dropping. That means the photosynthesis is not happening as it should. That means..." And you just need to keep on going back and going back and using deductive thought. And go over your records. "What did we do different? What happened?"

There's no one thing, Jon, that I can put my finger on and say, "Okay, that's what it is." You know what I mean?

Mr. Jon Frank: Okay.

One of the things I would say is look at the crop and see are you going through a phase change in the crop physiology? Are you suddenly having a higher demand because maybe it's filling? You know, if you go from just putting on little ones to filling bigger ones and plus putting on new clusters, that's

a big change. And so, it might be possibility to see if maybe you have to raise your base level of ergs.

Mr. Duane Headings: Okay. That's a good point.

I was going to say you could probably see that in the ergs. But, you're saying if you go through a change, you might have to raise the base level.

Mr. Jon Frank: Yes.

So, if you're watching the leaves and, you know, let's say you're keeping your ergs at 400 and all of a sudden your leaves drop from 11 to six, my first thing is raise your ergs up a little higher and try keeping it at 550 and see what it does. And the leaves might come right back up.

Mr. Duane Headings: Well, generally, you will see that in the ergs anyhow because the ergs isn't going to set there. If you take the ergs every day, you will detect that in the ergs when it starts. You will when it starts forming seed, when it starts to fill fruit, any of those changes. You can detect that.

The ergs tells you so much it's amazing. It's really amazing.

Mr. Jon Frank: Okay.

I have a couple questions. What happens when the conductivity, the pH, is too high? How do we manage it to get it back down into the optimum range?

Mr. Duane Headings: In the soil?

Mr. Jon Frank: Yeah. So, the ERGS--the ECB electrical conductivity. So, ergs and pH gets high.

Mr. Duane Headings: Both?

Mr. Jon Frank: Yes.

Mr. Duane Headings: At the same time?

Mr. Jon Frank: Yeah.

Mr. Duane Headings: Well, what's the soil test say? That would be the first thing. It depends on where the ergs is coming from. That brings to mind, of course, a greenhouse in Iowa where the ergs was way high and it was a low calcium situation. So, we did add calcium in the form of micronized lime.

Sometimes that can just turn into a tiger and you've got to hold the end of the tail and that tiger weighs a ton. Sometimes it can turn into that and there's not a whole lot you can do except try to ride it out and stay on your feet.

Mr. Jon Frank: So, in other words, we could do some fertigation of the micronized lime and that program with no soluble nutrients, really, but try to get some more available calcium there?

Mr. Duane Headings: The number one thing is don't put on more of what you have enough of. That's number one. It's so

simple and so basic. Don't put on more of what you have adequately already. Don't do it.

Mr. Jon Frank: Now, did Daniel Beechy's strawberries have a situation with high ergs and high pH and we were fertigating?

Mr. Duane Headings: He had a very high ERGS.

Mr. Jon Frank: I thought it was kind of a little bit higher pH, too.

Mr. Duane Headings: I'll grab the file here.

Mr. Jon Frank: Okay.

Mr. Duane Headings: But, what I'm saying is if you have a high ergs, you have high levels of nutrients, sometimes you really can't do a whole lot about it except sometimes you can water. That's one thing you can do. Use low conductivity water and if you have a soil that percolates well, you're lucky. And just water it and just flood it. Try to water it out.

Mr. Jon Frank: It would be a lot easier to do that if you didn't have plants. You could just really do a heavy washing of the water and maybe drop some of the ergs that way.

Mr. Duane Headings: Yes. If you have plants, then you get watery crop.

And I'm trying to find here--there are his strawberries. Yeah, we had a 7.0 on the pH, and we had 2,600 on the ERGS. We had 700 on the calcium, 3,200 on potassium, and 2,800 on the

phosphorus. That was a situation where we had high ergs, a 7.0 on the pH. Not too high but it's high.

And we did flush that one. We did flush it with water. We tried that. We had extremely low calcium at 700 pounds so we fed it micronized lime to try to get a crop that was halfway decent because we knew you can grow plants with--oh, here's another thing. The nitrates were 250 and the sodium was very high at 72. So, how much that was adding to that 2,600 on the ERGS, I don't know. Probably a lot.

To try to get a crop, we knew we had to have calcium in that cell. Go back to that cell. We knew we had to have calcium in there, so we added micronized lime. And that helped to buffer some of those high levels of elements. It helped to buffer those so the damage to the plant was less and it gave us a calcium source. And we also put in bugs and sugar and so on to break down that calcium. So, it gave us a calcium source so that we could get calcium into those cells.

And we wound up getting a fair decent crop off of there, I guess. It wasn't nothing outstanding but it was better than nothing. So--.

Mr. Jon Frank: --From what I remember, he was pretty happy about the crop that he did get.

Mr. Duane Headings: Yeah. The year before he had 200 pints and this year was about 2,000 pints, something like that.

Same greenhouse. He had a little bit more plants, maybe, the second year but not much. Not that much more.

And the brix on his strawberries, he had sevens to nines, I believe, in that range. I think nine was about the highest he got out of that greenhouse.

Mr. Jon Frank: Okay.

Well, that's interesting that he was able to get some production anyway, and used some calcium in that and micronized limestone.

Mr. Duane Headings: And another thing for those people who don't know about this situation, that greenhouse was put up over an old farmyard or barnyard. So, don't put your greenhouses on old barnyards.

Mr. Jon Frank: Okay. We hear it twice.

Mr. Duane Headings: Oh, that's like me. I need to hear it more than once.

Mr. Jon Frank: Well, that's good.

When I was gone, did you cover much on the use of milk going through the drip lines?

Mr. Duane Headings: Not much.

Mr. Jon Frank: Do you feel like that's a valuable thing or tool?

Mr. Duane Headings: I think it can be. From what we're seeing, I think it can be. We're seeing that it will help size

the tomatoes very rapidly or faster than--and here we go again. Never say never and never say always, but our experience here is that it's helping the tomatoes to size and it's bringing the brix in the leaf up. Those leaves will just thicken. It's a very nice source of calcium and also phosphorus, and it will thicken those leaves. The brix in the leaf is up to 15, and I attribute it some to the milk.

We did pick up on the frequency of the foliar spraying. But, I think the milk is doing some good things. And we are just using store milk, pasteurized, homogenized and so on.

Mr. Jon Frank: Okay, what kind? Whole milk, 2 percent, skim?

Mr. Duane Headings: I don't even know. I just told him to get some milk.

Mr. Jon Frank: Okay.

And I want to make a point that the milk always goes in fertigation number one, which is the growth side of things. There's way too many acids and problems, and it could coagulate and plug up some things in fertigation number two. So, always keep that on the growth side.

Mr. Duane Headings: And another thing is that we're putting in a little bit of vinegar. And when you're putting in micronized lime, that's a good thing but you can overdo it easily. And that's why it's important to monitor your pH.

Mr. Jon Frank: --Okay. Vinegar goes in fertigation number two?

Mr. Duane Headings: Right. That goes with the reproductive side.

Mr. Jon Frank: Okay.

Mr. Duane Headings: And here's a very interesting thing. We were having pHs down close to five. And so, sometimes you have to fight fire with fire. So, we started putting in an ounce of vinegar into this greenhouse in fertigation number two, and that pH jumped up. It came up by adding that vinegar.

In other words, we were solubilizing more of that micronized lime--this is a theory. Solubilizing more of that micronized lime and the pH was coming up. We were creating a greater level of resistance so we had more energy because there was more resistance to the flow.

Mr. Jon Frank: Okay.

So, then are you continuing that, then, using apple cider vinegar?

Mr. Duane Headings: Yes.

Mr. Jon Frank: Okay.

So, looking here at your more recent level of ERGS, you're in the 500 and 600 range and then sometimes dropping down into the 400s.

Mr. Duane Headings: That was because of the overwatering.

Mr. Jon Frank: The overwatering, okay. All right.

So--but, you think that you can get it back up in the 600s and maybe push it up to your ideal that you're looking at with 700?

Mr. Duane Headings: Um-hmm. It was 650 this morning.

Mr. Jon Frank: Okay.

And you are putting out some additional nitrogen besides the fish in the form of ammonium sulfate and maybe sometimes urea, or did you drop urea?

Mr. Duane Headings: No, we're using urea because of the pH issue. Ammonium sulfate drives the pH down. Urea drives it up. And so, we were alternating.

Now, urea doesn't have quite the kick that ammonium sulfate does. In other words, it will not push the ergs as high as ammonium sulfate will. And urea is 46 percent nitrogen. Ammonium sulfate is 21, 22 percent nitrogen. So, if you do urea, cut the rate in half from ammonium sulfate. Don't overdo that.

But, we're going back and forth because our pH is running down around five and we don't want it to go below that, really. The plants are doing fine, so we're not having any bad effects. But, we go in there with urea and then we see the pH come up a little bit, the ergs go down a little bit. We go back in there with ammonium sulfate, the ergs comes back up, the pH goes back

down. We're walking a tightrope across Niagara Falls. We're playing this thing just as hard as we can play it to get production out of there that we can so that they can get their money out of this thing.

Mr. Jon Frank: Okay.

Let's bring that up. Are they making money now? Is it worthwhile for them to follow this program?

Mr. Duane Headings: Yes, they weren't making anything. They said they weren't making anything. And so, anything's better than that. But, yes, at 500 pounds of tomatoes a week, and they are selling--they sell them local here for $3.00 a pound. And then, the excess they were taking to a produce auction and they were getting--I think they got $1.50 maybe, something like that. I'm not sure, but it wasn't nearly as much as they got locally. And they're working on local markets to sell more here locally because obviously the price is better than at the auction.

Mr. Jon Frank: Right.

Mr. Duane Headings: But, yes, they are making money.

Mr. Jon Frank: Okay. Well, that's a big deal.

Mr. Duane Headings: Yeah.

Mr. Jon Frank: Let's talk a little bit about how, after following this program a little bit, we feel like the potassium

has begun to slip, and then we have had to address potassium. And what do you look for signs for a shortage of potassium?

Mr. Duane Headings: Well, this is thanks to David Yoder. We were seeing a lot of the cluster branches breaking or kinking. And the tomatoes do size very rapidly when you have the ergs at 600, 700, the brix in the leaves at 11 and 12 and above. The tomatoes size much faster than when the brix in the leaf is at six and the ergs is at 400.

I just blamed it on that. I thought we were sizing tomatoes very quickly and they needed to get those clusters tied up. David Yoder told me that he almost never ties his clusters up. Doesn't need to. They don't break down. And he said that's a potassium issue.

And so, our last test came back potassium at 257. Is that correct?

Mr. Jon Frank: Let's see. The most recent one was--yeah, 200.

Mr. Duane Headings: Two hundred.

Mr. Jon Frank: So, that's getting really pretty low in a greenhouse. That's low.

Mr. Duane Headings: And so, we're starting to put in some soluble high pH potassium. And we just started that three, four days ago, so it's too early to tell what that will do as far as helping to increase the strength of those cluster stems.

Mr. Jon Frank: So, watch clusters bending over as a potassium shortage.

Mr. Duane Headings: I would say so. That's what David told me. And it makes sense to me because potassium is what holds the fruit onto the plant. So, we're not actually talking about the attachment of tomato to the plant, we're talking about the branch coming out to the tomatoes. But, potassium also determines the caliber of the stem. So, I think it's a good theory.

Mr. Jon Frank: Well, I know there's been some problems. Some people can--I've heard some stories of people getting real excited about micronized limestone and fertigating. And potassium was not addressed, and it was definitely to the detriment of crop yield and crop quality. So, we don't want to emphasize calcium to the point of excluding potassium.

Mr. Duane Headings: And that brings up another point. If your nutrients are way out of whack on your soil test, you can have adequate levels or excessive levels of this or that and you can come up with a potassium shortage for the plant in some situations.

And this situation, we had a extreme nitrogen shortage. And all the elements go into a plant phosphate form except nitrogen, and nitrogen can take up potassium. So, generally when you're high in potassium, you're going to have plenty of it

because usually you have plenty of nitrogen to take it into the plant.

Well, if you're extremely low on nitrogen, nitrate nitrogen specifically, and ammonia nitrogen, I don't know if it makes a difference there but your potassium uptake is not going to be happening with nitrogen. So, if you have a problem with nutrient uptake, which we did - I'm just saying the potassium levels on the first test was 400 and something - that doesn't mean that we had enough in the plant.

And yeah, I can hear you say, "Well, do a tissue analysis." Well, we haven't done any tissue analysis on this one. But, that doesn't always tell the whole story. I'd rather go with a soil test and a conductivity meter any day than with a tissue analysis. I think a guy can raise a lot better crops with a good soil test, a conductivity meter, and a pH meter than with a tissue analysis.

Mr. Jon Frank: And you'd probably want to throw in a brix meter there to keep checking the leaves and stuff like that once in a while.

Mr. Duane Headings: Very helpful. Definitely.

Mr. Jon Frank: Well, that's been a lot of things that we learned. I'm really very appreciative for this interaction with you, and you with Gary there because we've all been learning. And that's really the purpose of this call is to try to see if

we can get some points clear about this thing and get some principles down on paper to think about.

Do you have anything you would like to add, Duane, on different things, the overall ideas?

Mr. Duane Headings: Yes.

Mr. Jon Frank: Okay.

Mr. Duane Headings: On the overall idea, don't take any one thing and run with it. It's not the way it works. You have to have everything working together. That is one--that's one last thought I would like to give. Do not run with any one thing.

You have to have the soil test. You have to have the conductivity. You have to have the pH. You have to have the lime. You have to have the nitrogen. You have to have potassium. Don't take any one thing and hold it up and say, "This is what we need. We're going."

You need to figure out what you need, where you are, why you need it, how much you need, and then use it. And sometimes you have to do a little bit of experimenting and hope you're on the right track.

Mr. Jon Frank: Yes, you know, and I would say this. Don't take the soil test and the recommendations and follow just that.

Mr. Duane Headings: That's right.

Mr. Jon Frank: I mean, that is only a snapshot in time. So, the farmer, the grower, has to be monitoring daily, especially in the greenhouse, and adjusting because in making recommendations, we can only give a suggested or a beginning. So, the tomatoes might be pre-bloom when I get the soil tested or make a recommendation. But, the situations change and so you've got to be able to adapt with that crop.

Mr. Duane Headings: I'm glad you brought that up. Don't take the recommendations as a hard, fast rule. It's a good foundation. It's excellent foundation, but then when you get into the solubles there's no way to forecast everything that's going to happen. What if you overwater? Then, you need to put in more to bring the ergs back up. What if, what if, what if? So, that's a very good point.

Mr. Jon Frank: I think I'm writing that down as a real takeaway is that you have to add to it. And you can start with that, but then monitor and adjust.

Any thoughts on trying to do this whole thing organically, for a few people that may be growing this organically? Any thoughts on that?

Mr. Duane Headings: It's kind of like taking a canoe trip up the Missouri doing it this way. And now, when I say conventional, I'm not talking about chemicals or spraying chemicals. We're working with it as hard as we can to do

everything we can to get the nutrition up in the fruit that we eat. That's the goal. That's the bottom line.

Okay. So, doing it this way and we're taking a canoe trip up the Missouri. We've got two guys in the canoe, two strong guys, and both have a good paddle and we're heading up the Missouri, you know, going upstream. We're going pretty good.

Now, if we want to go organic, only one guy has a paddle and one of his arms is tied behind his back. We might get there, but boy, it's going to be hard work.

That's kind of my thoughts on it. Now, that might be exaggerated for clarity. But, can it be done? Yeah.

That also depends on where you're starting from.

Mr. Jon Frank: That's true.

Mr. Duane Headings: If you have a nice situation to start from, if you have enough phosphorus, if you have enough, then it might be a piece of cake.

Now, thinking about this situation that we just covered tonight, trying to do this organically? No, I don't think so, you know? So, it depends on where you're starting from.

Mr. Jon Frank: Okay. Well, that's a good point. I really appreciate your point.

David Allan, are you online? Can you speak?

Mr. Duane Headings: Hey, Jon?

Mr. Jon Frank: I gave him the access. Okay.

Mr. Duane Headings: Can he just push star-six or something like that?

Mr. Jon Frank: Yeah, he might have muted himself. I don't know. But, if he didn't call in as the organizer. I just wanted him to see if he had a few words to say. If he does, fine. We'll just go on for a few more minutes and then if you do not, we're going to call it a night.

So, we didn't cover greenhouse number two, but I think that's fine. We got the major principles out of greenhouse number one.

One thing. I guess Wendell was there with Dr. Skow and I one time, and a few other things that we noticed. Wendell noticed that if you're going to be planting these tomatoes that are going to hang down from a greenhouse like these are, and they're hanging on a tie-up thing, it would probably be good to plant the tomato at a angle so that when you have to lower the tomato plants, there's not a breaking at the base of the plant.

So, that would be another one is plant it at about a 45 degree angle in the direction that--so you can start to wrap that around without causing a big break or a kink, basically, at the root.

The other thing to note was that these are all hybrid tomatoes as far as I am aware. And so, maybe as we get the soil right, we might be able to experiment with a plant or two that

are not hybrids and see what we can get with brix. But, in everything we're talking about tonight, we were talking about hybrid tomatoes. Can you confirm that?

Mr. Duane Headings: Yes.

Mr. Jon Frank: Okay.

Mr. Duane Headings: Another thing that you have to be careful about is your water quality. That can be a big issue.

Mr. Jon Frank: It is my conclusion that long-term, we have discussed, it is probably good to get a system that cleans up the water even for the fertigation. Maybe putting in some kind of a system, maybe RO or something that will clean it up, especially if you have a little higher conductivity.

Okay. That's all I got, and we're going to hang this up. I want to thank everybody for listening and we'll try to get this made available.

I'd also like to offer people--I'll try to get a copy of all of these takeaway points and put that up as a download. Or, if you're not doing Internet, if you want to call the office after about a week or so, we can probably have that available. We can mail it out, just some of the takeaway points from this.

And again, thank you. And thank you, Duane. And especially give our thanks to Gary and Eldon for their willingness to share and let this be talked about.

Mr. Duane Headings: Well, thanks a lot, Jon. And I hope it was a help. I hope it can help people to better monitor and to better produce better crops.

Mr. Jon Frank: Okay.

And I guess with that, we'll say God bless and good night.

Mr. Duane Headings: Good night, Jon.

Mr. Jon Frank: Okay. Bye.

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