Episode 108_mixdown PROOFED

Thu, Aug 25, 2022 10:27AM • 1:03:23

SUMMARY KEYWORDS

bees, colony, hive, colonies, honey bees, pesticides, study, beekeepers, sensors, work, very low concentrations, research, temperature, brood, beehive, nectar flow, honey bee, pesticide, levels, parts

SPEAKERS

Amy, Stump The Chump, Serra Sowers, Jamie, Guest

Jamie 00:13
Welcome to Two Bees in a Podcast brought to you by the Honey Bee Research Extension Laboratory at the University of Florida's Institute of Food and Agricultural Sciences. It is our goal to advance the understanding of honey bees and beekeeping, grow the beekeeping community and improve the health of honey bees everywhere. In this podcast, you'll hear research updates, beekeeping management practices discussed and advice on beekeeping from our resident experts, beekeepers, scientists and other program guests. Join us for today's program. And thank you for listening to Two Bees in a Podcast. Hello, everyone and welcome to another segment of Two Bees in a Podcast. Today, we are joined by Dr. William Meikle who is a research entomologist at the Carl Hayden Bee Research Center for the USDA ARS in Tucson, Arizona. William and his colleagues conducted an interesting study that they recently published. We're going to make sure and link this manuscript in our show notes today so that you guys can check it out. But in the study, the title of the study is, "Traces of a Neonicotinoid Pesticides Stimulate Different Honey Bee Colony Activities, but do not Increase Colony Size or Longevity". So it's going to be a bit of a different spin on how a particular insecticide might impact bee colonies. William, thank you so much for joining us on this episode of Two Bees in a Podcast.

Guest 01:39
Thank you for having me. It's wonderful to be here.

Jamie 01:42
William, the listeners don't know this, but I'm about to tell them, I actually spent a little bit of time with you in Puerto Rico a couple of years ago, you and I were at the same meeting. And it was just really fascinating to hear about your research. We could bring you on again to talk about some other things that are neat that you do. But I'm really excited to have you on and can't wait to introduce our listeners to you. So let's just start there, William, how did you get where you are? What do you generally do as a research entomologist at the USDA out there in Tucson? And how did you find yourself loving bees?

Guest 02:13
Yes, I'm a research entomologist here in Tucson. And I focus mainly on colony-level effects of different kinds of stressors often, but actually just different kinds of factors. Now, we're also looking at green lines and the effects of that on colony behavior. So I've been here for a little over nine years. I was

working in a lab in South Texas that was closed by the USDA. And before that, I was at a lab USDA lab in southern France for eight years. And before that, I was in West Africa, in Benin in West Africa for eight or 10 years where I did my doctoral research and did postdoc work and I was a scientist at an institute there and that's where I started working with honey bees in West Africa. So these were actually African bees I got really interested in there.

Jamie 03:22
Was it adansonii you were working with out there?

Guest 03:25
I'm guessing so.

Jamie 03:26
Okay. All right. For the listeners benefit, there are multiple subspecies of Apis mellifera that live across Africa, and I think William, if I'm not mistaken, so Apis mellifera adansonii is the one that might be out in that direction. I'm not sure. I was in Ghana years ago and encountered some honey bees there and didn't know much about the subspecies at the time, but in hindsight, I was guessing maybe they were adansonii. Were they pretty defensive while you were working with them?

Guest 03:50
Yes, they were. I do believe they were adansonii. I agree with you. They were defensive. I've also come across plenty of defensive colonies here in the US. They're a little bit tricky to work with. Did not like many interventions. It was pretty basic beekeeping, but very interesting nevertheless.

Amy 04:17
So it seems like you've had a lot of experience with honey bees and honey bee research. So I'm really excited because we have a reading group where we basically read literature and new publications that come out weekly. And so the lab just comes together, we discuss papers, and you've come out with actually a couple of recently published papers on pesticides. And so we wanted to bring you on and invite you to discuss one of your papers specifically looking at neonicotinoids. And so you examine traces of neonics and your title actually suggests that pesticides stimulate honey bee colony activity, so that was kind of a new take for us to see and read about. Can you just tell us what this means? What does it mean to stimulate the honey bee colony activities, especially with pesticides?

Guest 05:10
Well, a big focus of our lab here in Tucson is on the use of sensors to monitor colony growth and behavior. So we use hive scales, for example, temperature sensors, CO2 sensors, and humidity sensors to monitor colonies when we expose them to different kinds of stressors. The stressors might be nutritional stressors, or in this case, it's agrochemical stressors. So we have been investigating the impact of pesticides on bee colonies by putting very low concentrations of pesticides into the food that we give the bees. So that's the main method that we expose the bees to the pesticides.

Amy 06:01
So basically, you guys were looking at pesticides, and you were looking at honey bee colony activities. I'm not a researcher. So William, I have to tell you, I am an Extension person, which means that I don't

really understand research, as much as I probably should understand it, but I guess just trying to figure out what people are looking at when they use pesticides, you said something about feed? And so do you take the pesticide and just put it into a pollen patty? Or do you put it into sugar water? Or what are you looking at specifically?

Guest 06:37
Oh, very good. Good questions. Okay. So one of the main focuses of the work that we do here in my lab at the Carl Hayden Research Center is on the use of sensors to monitor bee colony growth and activity. We use different kinds of sensors, for example, hive scales are a kind of sensor and temperature sensors, CO2 sensors that we put inside the hive. The object of that is to find out how the bee colonies are behaving within the hive. We're interested less in the effects of these stressors on individuals than we are on how the stressors affect the colony itself. Of course, we also do hive assessments, or periodic hive assessments to measure the adult bee populations and measure the amount of brood there is in the amount of food in terms of pollen and honey. But the focus of our work is on the way that the colony's behavior affects these different sensors.

Amy 07:49
Okay. You know what's really funny is that when I brought your name up and told Jamie that we were interviewing you today, he said, "Oh, William loves using sensors. Their research is all about using sensors." So that was really fun to hear.

Jamie 08:04
And I will say on top of this, William, when I see a lot of people do sensor research, let me just restate this, I get a lot of people coming to me saying, "Jamie, we produce these sensors and we want to do all these things with them." And one of the things that I always say is, "Listen, collecting temperature data and humidity just to have it is kind of meaningless. We don't know what it does." And I think one of the things I appreciate about your lab is you're trying to say, "Hey, when our sensors are giving us these readings, humidity, temperature, CO2, etc. this is what we're seeing happen in the colony." It looks like in this particular study, you mentioned you put a pesticide in pollen patty, you're doing a sublethal dose. You're putting it into a colony, and you're asking yourself, what is that doing to the things that I can measure with sensors? And I think that that's fascinating. I call it ground truthing. It's a GPS, or a GIS phrase, which is yeah, you can look at Google Maps, and see that there's supposed to be a field here, but you ultimately have to go ground-truth it and know that there's a field there. Well, in your case, you're generating all this sensor data, there are responses, but now you're physically going into the colony and seeing how that correlates with these colony-level phenotypes that you're talking about and that's just really neat to me.

Guest 09:16
You touched on a very interesting point. A main focus of the work that we do is on interpreting sensor data. So, for example, hive scale data, weight data, you can have a look at hive weight changes from day to day, like how much the hive might gain or lose for one day to the next. But if you look at the hive weight within each day, you can get an idea of say, colony activity, foraging success, when the colony starts its activity, when it finishes its activity at the end of the day, how much weight it's losing at night due to the nectar drying or whatever. So there's a lot of information in there that can be mined, if you are taking, for example, weight measurements often enough. We tend to take it like every five minutes.

Let's take the example of temperature. Temperature we don't take so often, it's like every 15 to 30 minutes. And we break the temperature data down into your average temperature. So just what the average temperature is at that point in the hive, and the temperature variability. So when a colony has a lot of brood, bee colonies tend to have very, very low temperature variability. So in other words, it doesn't change very much. In fact, it changes about half a degree centigrade, at most, during the raising of brood. So they have a very, very low temperature variability. But when they are raising less brood, or particularly when they stop raising brood, the temperature variability goes way up. And of course, the average temperature in the hive also tends to go down. So you have these very, they're different aspects of temperature. But we measure both of those things to see how different stressors or different kinds of things might impact a beehive. I say stressors, but there are a lot of other aspects, of course.

Jamie 11:22
That's just like mind-boggling. This idea that bees can even detect a half-degree difference, that they're trying to maintain in a brood nest, that's just like mind-boggling. To put this all together in your research, you were dosing colonies with this sublethal dose of imidacloprid. Right? Was it imidacloprid?

Guest 11:41
Yes, it was imidacloprid.

Jamie 11:42
Okay. And then you're measuring these other things using sensors. Could you tell us a little bit about the structure, then, of the study? You had different treatment groups, you had the senors taking these measurements. Tell us a little bit about the experimental design.

Guest 11:59
We conducted this study, the paper that you're referring to, over five years. So every spring we got a series of new colonies, made sure that the colonies were queenright and had plenty of brood and all that is as consistent as possible. And then we divide the hives into treatment groups. And they were all kept in the same apiary over distances between hives, but kept in the same apiary. This is something that's that maybe we can talk about a little bit later when you're doing pesticide studies, and the importance of keeping hives separate, but we put these hives in the apiary and put them into one of, say, three groups: a high pesticide exposure, low pesticide exposure, and no pesticide exposure. The high pesticide exposure might be 100 parts per billion. In this case, it was 100 parts per billion of imidacloprid. I think we also did 20 parts per billion of imidacloprid. So we had a fourth treatment group in there. The low one was five parts per billion of imidacloprid. Now, five parts per billion of imidacloprid is not very much. It's about if you've got about, oh say, half a golf ball's worth of imidacloprid dissolved into an Olympic swimming pool. It's a very, very low concentration. Now, imidacloprid is one kind of a neonicotinoid. We've worked with other neonicotinoids as well. But it's also soluble in water. So we put this into sugar syrup that we fed the bees. So we set up these beehives and then prior to applying any of the sugar syrup that's been treated with the pesticides, we evaluated the colonies to make sure we knew what the brood levels were, colony size and all that. And we removed all of the stored honey that we could that did not have, for example, on a frame, if it didn't have brood, then we would remove all the frames that didn't have brood and replace them with frames that had drawn comb so the bees had some place to store the sugar syrup that we were going to feed them. So now the colonies would be full

of adult bees and be queenright at the start of the experiment. But we knew that they would, because they didn't have any stored food, we knew that they would be very interested in storing any food that we gave them. So then we applied this sugar syrup. Twice a week we'd give them, oh, I don't know, say four to six pounds of sugar syrup that had been either tainted with imidacloprid at those given concentrations, or just plain sugar syrup for the control group. Did that for about six weeks. And at six weeks we would evaluate the colonies again and take samples of, for example, their stored honey to make sure that they were storing the sugar syrup that we had given them. We did this during the month of August and in southern Arizona, this is a period of dearth. So we knew the bees would be very anxious to have some food to store and feed the adult bees and the larvae. Now, of course, before the experiment, we also installed these temperature sensors and CO2 sensors and put the hives on scales so that we could monitor their activity and thermal regulation and their CO2 management during the course of the experiment. Bbut it was really interesting after the six weeks. After six weeks, you knew all of the bees, or most of the bees, if not all of the bees in these colonies, had been raised on this tainted sugar syrup. And so this is a very interesting period of time. So also in September, which would've been after the experiment, we tend to have a slight nectar flow. So this is a time we can go and see how pesticide exposure might be affecting foraging activity, for example. And then in October, of course, if you start reducing the brood, so this is when we can see how the imidacloprid might be affecting thermal regulation, as the colony started to slow down and stop its brood production.

Amy 16:50
So I have so many questions for you about the project but with the sensor data, so you had the hives on and testing all these sensors for the entire six weeks that you did the study plus some? Or what did that look like?

Guest 17:09
Okay, we kept the hives on scales and kept the sensors in the beehives until the following February.

Amy 17:14
Oh, okay.

Guest 17:14
So after overwintering. Monitoring hives during winter was also a very important part. We wanted to see what would happen if the colony had a lot of stored tainted syrup and that's what it subsisted on for the winter. So this was an important part of the study.

Amy 17:34
How do you keep all that equipment charged?

Guest 17:38
I'm sorry?

Amy 17:38
How do you keep all the equipment charged?

Guest 17:42

The hive scales are attached to deep cycle batteries, which are themselves charged by solar panels. So we had solar panels and controllers and whatnot in the field to charge the hive scales and the CO2 sensors. The temperature sensors, as it turns out, are these little tiny things called eye buttons and they have their own power. So that little tiny battery in there. So they did not need any external power. So another crucial part of this is that we always put our temperature sensors, for example, these little tiny eye buttons, we always put them in the same place in the hive, which is very important for interpreting the results afterwards.

Amy 18:26
Where do they normally go? Is it sort of in a brood box and towards the center? Or where?

Guest 18:31
Exactly, the top center, just under the top bar of the middle frame and brood box, in the brood box.

Amy 18:39
Okay, the other thing that you had mentioned earlier that I do want to touch base on is the distance, because you said there was something about the distance of having the hives during the study. So can you elaborate more on that?

Guest 18:50
Right, well, one thing that you find when you work with these bee colonies, particularly when you work with sensors, it's one of those unexpected results, but you realize that you are also monitoring how hives are interacting. Now, the problem with doing pesticide studies and one of the reasons why doing pesticide exposure with say, a high concentration of pesticide, which you expect, maybe that would be a good treatment group is to give them a super high level so that you know what's going to really hurt them. Well, the problem is if you have an apiary and some of the hives are being exposed to these high pesticide levels, enough to damage the colony, is those colonies become weak. And when you have weak colonies, they start to get robbed. So what we found was, well, sometimes some of these weak colonies particularly once it had high levels of pesticide, weak enough to get robbed, well, we not only can see that they're losing, for example, they'll lose two kilos in an afternoon, four or five pounds of honey in an afternoon. We know they're not eating it. They are in fact being robbed. Or we also noticed that when we gave the sugar syrup, the colony itself would then lose almost all of the sugar syrup in an afternoon because other colonies are stealing it. And not only that, but the other colonies are also on scales, so we can tell who's stealing it. So you can see all of these interactions going on. And so it's tricky when you're doing these pesticides studies. You want to avoid generating weak colonies because then they get robbed, and then the treatment itself is becoming -- it gets interfered with, if you will.

Amy 20:46
There are so many factors that go into honey bee research, and so many things that can happen, just things like robbing once a colony gets weak. But of course, that's part of the research, is trying to figure out whether something's making a colony weak.

Guest 20:59
Exactly, yeah, the problem when you're doing a manipulative study is when get weak colonies, everybody picks on them. This is a little aside, we don't have to include this in anything, you haven't

asked about it. But when I was in France is when I really started working with honey bees with USDA. In West Africa, it was just more of a hobby, I was working with another guy. But in France, I started a project and we worked on biocontrol of Varroa. And this was using Beauvaria bassiana fungus. So we treated these colonies with this fungi, these fungal spores, and then we would collect bees and try to determine which bees were, say, that the spore level within the colony, the average spore level per bee within the colony to see how well they were treated, how well they were coated with the the biocontrol agent, this fungus? Well, when you go into the control colonies, they also would wind up with plenty of these spores. And you realize that there is an incredible amount of drift going on in these colonies that you can't control but you were unaware of before. You just can't tell.

Amy 22:10
Right.

Guest 22:13
Finding this thing out about the pesticides is a bit like that. It's like an unexpected result. You have to be careful about interpreting things after that. And you have to be careful about monitoring things. Right. So that kind of leads me to my next question. What are some of the takeaways of your research? I know that there's a lot of pesticide research that's done in the laboratory. But you all did this outside in the field. What, in general, what are some takeaways from the research? Okay. Well, some of the takeaways of the research that we did was this study, particularly if we talk about imidacloprid, now imidacloprid is just one neonicatanoid, and I said, we've worked with other ones, and we did not get the, well not the one in particular, clothianidin, and we didn't get the same result. But with imidacloprid, we found that these low levels of low concentrate imidiacloprid actually did cause bees, they raised the average temperature within the beehive. I think two of our experiments, significantly reduced the temperature variability. They significantly increased the foraging activity as measured by the hive scale. So with the hive scales, because we measure the weight so often, we can tell when the foragers leave in the morning, and as they come back and how much weight they're bringing back. Well, that initial forger departure in the morning, quantify that, compare that among these different groups, and we found that they actually seemed to have a positive impact on that initial forger departure. It also affected the average CO2 concentration within the hive. So these are some very interesting aspects of colony-level behavior. But in the end, it didn't seem to have any role in increasing, for example, the adult bee population or increasing the amount of food stores or increasing colony longevity, any of these other factors that might be important that you might associate with improving colony health. So we'd say it seemed to stimulate activity, maybe, in these regards, but it didn't seem to have a measurable impact on colony health. Now, why would such a low concentration have a different effect than, say, a higher concentration? There is a certain body of work on the effects of dose-response curves, we'll say, on the shape of dose-response curves at very low concentrations of toxins. What some researchers have observed is that the dose-response curve changes. So that something that might be toxic at a certain concentration, at a very, very low concentration is not and provokes a different kind of response by the organism. It's called hormesis. I also liken it, maybe it's just very, very low concentrations of some kind of acetylcholine stimulator might increase activity in the sense of like drinking a cup of coffee might increase your activity, your physiology, but more might increase your activity level, but it might not necessarily help your health in any way.

Jamie 26:06

I think when we were reading this manuscript, William, as a lab, I think that that was one of the interesting things that came out to us. Number one, that you saw some effects that were not necessarily negative. But number two, it didn't seem to manifest it, didn't seem to change colony health at the end of the day. So just like what you said, you get tighter temperature control, this, that, the other, but at the end of the day, the bees didn't necessarily live longer, or were stronger, etc. But what is interesting is also the idea that you didn't seem to see what you would have considered maybe a negative response to imidacloprid exposure. So I kind of have two questions. One of those is I'd like to talk a little bit about the imidacloprid levels you tested, kind of how those were chosen. In other words, were those consistent with exposure scenarios that you saw in the literature? And number two, I would ask, so what would this mean for beekeepers who read this study or listen to this interview? What are some take-home messages for them? So let's first start with the imidacloprid levels, I wrote down what you tested. Let me go back to that in my show notes here. You tested 100, 20, and five parts per billion of imidacloprid. Can you tell us a little bit about those exposures regarding or at least relative to typical field exposure scenarios?

Guest 27:28
We based these concentrations on data that we've gotten from publications and literatures. There are several research groups that have gone out, collected samples from commercial beehives across the United States, and reported the pesticide residues in those. So that's how we based it. We picked the lower end. And then we try to get a higher end for the concentration of the conservation, 100 parts per billion in the case of imidacloprid, we figured would be a very high end. I don't think that, typically, hardly ever occurs in the field. So we wanted something at a high end. And we picked imidacloprid, because of course, it's a very common neonicotinoid. At least it was it's time, probably when the most common pesticides in the world.

Jamie 28:19
I love the fact that you guys went to the literature and checked residue literature. And basically you're just using residue levels that have been reported to be in these things in hive products in the field. That's really neat. So beekeepers listening to this, there's been a lot of discussion about the impacts of pesticides on bees. Often when the word pesticide is mentioned, there's a very negative connotation associated with it. And you guys found, I guess, to make a summary, a neutral impact of imidacloprid on colonies, a neutral, meaning no impact at all, but also neither good nor bad. You found some things that were happening, but it didn't seem to change things at the colony level. So what are some beekeeper-related take-home messages that they can get from the research you guys have done?

Guest 29:05
Well, one take-home message, I think, is that that it's very possible that the dose-response curves do change at these very low concentrations, and that beekeepers should probably not be afraid of these very low concentrations. In fact, we have a hard time demonstrating that these low concentrations have much negative impact on bees at all. We've looked at, like I said another neonicotinoid, clothianidin, and we also published a paper on methoxyfenicide, which is an insect growth regulator. That one is not readily soluble in water. So we applied that to pollen patty. In any of these studies, they were all about the same concentrations of pesticide and we didn't find that there were really any negative impacts that would have been, certainly not observable during a colony evaluation. Now, if you were monitoring a colony's temperature, something like that, then then you would notice it. But I would say one of the

take-home messages is that there can be effects on the bee colony and there might be effects that affect the colony that would be very difficult to observe on the level of the individual, if we were to look at gene expression or some kind of physiological measure, that would be very difficult to observe. But on the colony, maybe there are some effects that can manifest themselves. But these effects are not necessarily going to harm the bees. In fact, certainly, the imidacloprid colonies didn't do measurably better in terms of food storing or adult bee population growth. But they certainly did not do any worse. They did at least as well as a control colony, I would say.

Amy 30:56
So William, I had mentioned earlier something about lab research versus field research. And so you've discussed with us that this is an example of a field project. And so I'm wondering if you ever complement your field studies with, and I think you said cage studies, so I assume that meant lab. Is that right? So when a researcher says they're doing cage studies, does that typically mean it's a lab study?

Guest 31:20
Yes. This is a very common approach among bee researchers to explore certain effects on bees in cages in a laboratory where you can carefully control the environment, you can carefully control what they eat, and what they do. And you can look at different things, for example, bee longevity, and or say how much the bees eat in the cages. We also did some case studies with imidacloprid. We've done it actually with a number of different stressors, but in this case, imidacloprid. We did a sort of different take on our case studies. Now, in typical case studies you put a quantity of bees, usually newly emerged bees, because bees that had been, for example, if you just removed a bunch of random foragers from a beehive, it would be very difficult for them to modify the behavior to exist for any period of time in an incubator. So what we do, and this is a typical approach for bee research, is get a frame of brood and you let a bunch of bees emerge. So these newly emerged bees are then put into cages in large groups. And what's a large group? A large group might be 50 bees to a cage. Probably less than that. It's not really a good idea, at least not for our kinds of studies. But we try different size groups, 50, 100, 150, and 200. And another thing that we did differently is that, after the bees emerge, we put them in a bee cage and after we keep them in a warm temperature, I think 30 degrees, 35 degrees, nice warm temperature, let them eat a little bit of pollen patty or pollen and drink the syrup unadulterated. Then we start the study. And we change the temperature regime in the cage, in the incubator, so it becomes 12 hours at 30 degrees and 12 hours at 15 degrees centigrade. So we have this cycle, which we're thinking this would be like, for example, bees being exposed to life outside, where they would have warm temperatures during the day and cold temperatures at night. So we ran this experiment with a number of different-sized groups of bees. And we found that while the size of the group of bees is important, because at night when the temperature goes down to the 15-degree level, the bees tended to cluster, so we also added a little square of wax foundation in the center of the bee cage and put inside, at the center of that little square of wax foundation, we put a couple temperature sensors. Because we wanted to know when it becomes 15 degrees and the bees start getting very cold, are they going to cluster and are they going to generate any heat in that little cluster? Now, there's a big difference between bees in a cage and bees in a hive in that bees in a hive generally have brood that they're trying to keep warm. So bees in a cage do not. And the bees in the cage are actually all the same age. So there are a lot of differences between bees in the cage and bees in the hive but we were curious if we would get any kind of thermal regulation activity, if you will, in the cage. And we found

when we used different size groups of bees that it mattered. We did observe, actually, a temperature. The bees in the cluster did maintain a certain temperature, not very much, not as much as, say, in a beehive. But of course, it's a very small group of bees. But the more bees you had, the warmer it got in that little cluster during the 15-degree phase in the incubator. So we found that 200 bees per cage was a good number of bees, the bees seem to make it nice and warm in there. So we would have a good way of measuring any impact of exposure to pesticides. So then we ran the experiment with 200 bees per cage and gave them different concentrations of imidacloprid sugar syrup, of course, the same concentrations that we had in the field. And what we found was that when the bees got five parts per billion of imidacloprid, the temperature of that cluster was significantly higher than it was compared to control. Particularly compared to 100 parts per million of imidacloprid. So this confirmed the work that we've done in the field. In other words, the bees were warmer in those cages at 15 degrees when they had the five parts per billion imidacloprid than the bees in the cages without the five parts per billion imidacloprid, the other treatment groups. So this cage behavior confirmed the field behavior. So that seems to indicate that what we're observing is a real effect of this low concentration of pesticides.

Jamie 36:57
Did you see temperature differences at the 20 and 100 parts per billion imidacloprid?

Guest 37:03
It's interesting. At 20, we found very little difference between 20 and control. And 100, it was lower.

Jamie 37:15
Because that's what I'm wondering like, what about five parts per billion causes bees to be --

Guest 37:21
Warmer, yeah.

Jamie 37:23
What causes them to want to warm more?

Guest 37:25
I don't know. And I don't know if necessarily a higher temperature is a healthy thing. It has been suggested, well, maybe this is another unwelcome effect. But I have a hard time figuring out what way it's unwelcome. Of course, the temperatures we're talking about are very, very low compared to temperatures observed in the field, it's not 34, 35 degrees centigrade, it's just a few degrees above the 15 degrees, and say, 20 to 22 degrees. But why it would be higher? I don't know. I always look at it this way. And I don't think this is necessarily accurate and I touched on this earlier. But if you had a cup of coffee, this changes your physiology. You're going to express certain genes, it's going to change certain things, it's going to stimulate your heart and that sort of thing. So at a very, very low concentration, we have this sort of mild stimulatory effect that doesn't really have a negative impact. I don't know. But we did not find that the five parts per billion increased the longevity. And I'd have to review that paper, I can't remember if it changed their food consumption rates. But I don't believe it did. In the study, the 100 parts per billion actually had a lower food consumption, but the other three treatment groups at 20, 5, and control were all not significantly different.

Jamie 39:14
Well, William, that was so great. Thank you so much for spending time with us talking about your current research study.

Guest 39:19
Thank you for having me.

Jamie 39:21
Absolutely. Everyone, that was Dr. William Meikle who's a research entomologist at the Carl Hayden Bee Research Center at the USDA ARS in Tucson, Arizona talking with us about how neonicotinoid impacts different colony activities. And you can see the paper that he and his colleagues published summarizing these. We'll make sure to link it in the show notes so that you'll be able to find it. Thank you for joining us on this segment of Two Bees in a Podcast.

Amy 39:58
Well, Jamie, it was really great to have Dr. Meikle on today. As I mentioned earlier, he has a couple of publications that have just come out recently. So they all kind of came out at the same time. The methods are very similar to one another, and the one thing that they do have in common are the fact that they use sensors quite a bit, and I think that's really cool. And I also think that that's something that we're leaning towards, just as far as technology that beekeepers might be able to use in the future, and so let's talk a little bit about the sensors that he used and what he was measuring, and I guess what that means for us.

Jamie 40:33
Yeah, so Amy, one of the things that I firmly believe is that our industry, in general, we're pretty far behind the curve when it comes to incorporating technology into our industry. Now, I know that there are a lot of cutting-edge folks out there, I've even seen a robotic hive where the colony will remove frames and scan for various things and the computer makes decisions on management-related issues and put the hive back together. So there are definitely those things coming. But from the crop perspective, farmers can get in the cab of their tractor and set the GPS and the tractor plants the field and do everything for them. And we're just not there. We still keep bees now much the same way we did 50 years ago, 100 years ago. Maybe our trucks to move them are bigger, but it's essentially the same. So there's a lot of room for adopting technologies to help us be better beekeepers. One of the things though, is that a lot of folks come with these very low-hanging fruits, temperature sensors are cheap, right? They're affordable. Humidity sensors are cheap, they're affordable. Scales, they're cheap, they're affordable.

Amy 41:36
Right.

Jamie 41:37
So you collect all these data. Oh, the temperature is going up or down or the humidity is up or down or the weight's going up or down. So the question is, is what does it all mean? And it's really neat to see that William and a few other labs around the world are trying to correlate their sensor data with actual colony condition. A lot of companies have come to me over the years, "I want to be able to measure

this. And we can measure that and this and the other, would you please test it out and see if we can measure these things?" Yeah, well, I'm confident you can measure these things. The question is what does it mean from the application standpoint? So we need projects like this, where I might have fed imidacloprid and sugar water to bees and looked at brood and bees and Varroa mites and individual bee longevity, it's good to layer on top of these projects the sensor type readings that William is doing. So now that he can say, "Hey, when they are exposed at these levels, here's what was happening in temperature. When they were exposed at these levels, here's what we saw with CO2." And I think this is really what we need to get us into the future where we're trying to interpret what these sensor technologies can do for us and tell us about what we need to do for our bees.

Amy 42:49
Yeah, the second thing that I kind of wanted to talk about and just follow up on was that, as a takeaway, he said that we shouldn't worry about low levels of the imidacloprid in our colonies. That's really interesting to me. And I think, just from my experience of being an agent in an urban setting, I think a lot of that is just following the label, right? We've said that a million times, and a lot of people do tend to overapply because they think more is better. And that's not necessarily the case. But I guess going back to his words of advice of maybe we don't need to be worried about it, what are your thoughts on that?

Jamie 43:28
Yeah, so that was a very interesting statement. There are a couple of things I would think about. First of all, honey bee colonies have pesticide residues in them. You can find residues in wax, you can find it in pollen, you can find it in nectar, you can find it on the bees, etc. In fact, William mentioned the Mullin study that I believe was published in 2010 where they surveyed colonies around the US looking at agroecosystems to figure out what compounds they are exposed to. Just incidentally, Amy, some colleagues and I just published something this year, we're recording this podcast here in early 2022, we just published a paper in early 2022, where we looked at residue levels of compounds in colonies that were located in suburban and urban areas. So we find pesticides in colonies. And pesticides have really driven a lot of the bee loss discussion. There are a lot of people who have politicized this issue. Some of the science with it has been good, some of the science with it has been bad, there have been enemies made, just lots of issues related to pesticides. And so I feel like at very low levels, the collective research is suggesting, at a lot of these low levels that we're seeing in colonies, that these levels don't pose a great risk to bees. And so William was saying specifically with their research project, they found that these low levels of imidacloprid didn't seem to compromise colony level, health, and productivity, etc. And I think that that is important to hear. First of all, just because we see a pesticide in a hive, residue in a hive doesn't mean it's going to impact bees. You need to look at it from a risk perspective. We are also exposed to pesticides every day. But that doesn't mean they pose a great risk to our health unless we get exposed to high enough levels that might elicit a chronic impact or higher level, still, that might elicit an acute impact. And at the levels that he was testing, he's basically making the claim that he was not seeing a chronic or acute impact of these levels. And so beekeepers can take a deep breath that, at least this one research study suggests that at these levels, maybe there aren't impacts. And it's funny, I'll point out that we see this a lot in general, in lab studies versus field studies. There's a lot of stuff done in the lab that's creating a lot of hysteria with regard to pesticides. And then if that's ever carried to the field, that same effect seems to be lost at the colony level. Yeah, we see it in a cup, we see it in a plate, in an incubator. But when you get to the colony, it's like, you can't reproduce

that effect. And so it really tells me that there's so much work we had to do still with pesticide impacts on bees.

Amy 46:04
Well, on that note, what other follow up projects do you think need to be done just moving forward with pesticide research in honey bees in general?

Jamie 46:13
Well, I tell you, one of the things that was really interesting to me that he said is that honey bees, when there's a lot of brood present, can thermoregulate within a half a degree, right? And it's funny to me, Yeah, that's crazy. So when there's no brood or less brood, then presumably that error bar, or those confidence intervals increase, maybe they're within two degrees, or four degrees, or 10 degrees. So I circle that back to one of his key findings that at five parts per billion of imidacloprid, he was seeing slightly increased temperatures in those colonies but not at 20. And then lower temperatures at 100. So immediately, my mind goes to: so how does pesticide exposure cause a temperature change in a beehive? I know one could argue that 20 is four times bigger than five, and 100 is 20 times bigger than five. But when we're talking at the parts per billion level, that's really small, right? Five parts per billion and 100 parts per billion, while they're 20-fold different, it's still a small amount of pesticide, yet five made it go up, 100 made it go down, and 20 did nothing. So how is it at these tiny differences between these residue levels they are eliciting completely different responses by the bees? And so those kinds of questions are questions I'd love to have answered. We saw this, how does it happen? How does a pesticide trigger a temperature increase in a hive or a temperature decrease in a hive? And is this true across all related compounds? Imidacloprid is a neonicotinoid. What about other neonics? Is this a neonic? thing? What about insect growth regulators? So there's just so much in this that I think that they could follow up with. It's just a neat spin on some pesticide impact research compared to other spins that I've seen recently. It's kind of a neat look.

Amy 47:01
Oh, that's cool.

Stump The Chump 47:16
It's everybody's favorite game show, Stump the Chump.

Amy 48:21
We are at that question and answer time. And Jamie, I really liked this first question. Is it possible that the bees are hearing my voice? And I mean, really, the question is, can bees recognize us through our voice and just through our presence? And then the second part of the question is really funny, it asks, do honey bees react to music? So, was that your PhD project? Like listening, looking, watching behavior with music?

Jamie 48:33
It wasn't my PhD project, for sure. But maybe someone's done it. So bees don't have ears, right? So they cannot hear, in the sense that, maybe, the questioner is asking. They can feel sounds and they can perceive sounds, but it's not hearing it the way that you're hearing my voice now, or the way that those of you listening to this podcast are hearing my voice. So a lot of people have played music for a

lot of different biological things and tried to record the response of those things to music, like I said, plants, we know humans, etc, dogs, things like that. So we do know, of course, that bees can sense these vibrations. In preparation for this, I found a really interesting article that talks about how bees use acoustical signals for communications. We know that they buzz and all of these things, but a lot of these are probably perceived more so as vibrations rather than in the traditional sense like you and I will talk about hearing but we know, for example, that queens pipe. We've had a podcast interviewee talk about that so we know that they can-

Amy 49:57
And they toot!

Jamie 49:57
Exactly they pipe and they toot. What was the tooting sound, Amy, again? Okay, well, anyway. So, in science, and especially with honey bees, nothing surprises me. So if someday people show that they can recognize our voice and they can hear Jamie and know it's Jamie, and differentiate Jamie from Amy, I would not be surprised. But I would say at the moment, if they do, it's likely very minimal. I don't think they know that I'm coming. A lot of people say, "Well, can bees smell us? Do they recognize their keeper in general?" But worker bees don't live that long and there's just a lot that kind of works against them becoming familiar with us, either from the voice perspective or the smell perspective, or just the "I've been around you a few times so now I know you" perspective. Neat thing. I wouldn't be surprised someday if we find more about this. That bees can hear in the sense that they can distinguish between voices, but at the moment, I think the collective evidence says that it's not that important in the bee world, at least learning how I sound, you sound, even though I do believe if you play our podcasts, all of your colonies will be stronger and healthier.

Amy 50:01
Wait, what was the name of the title of the article that you found? I don't remember.

Jamie 50:55
Well, Amy, when you Google search lots of things you get lots of different articles. So one of the ways that I try to, I promise I'm going to answer your question, one of the ways I try to answer questions is I will look on Google Scholar which helps me look for research articles related to the topic. So I Google Scholar, "can honey bees hear?" or "how do honey bees perceive music?" and things like that. There are a few papers that mentioned acoustical signaling in bees, all that stuff that I kind of shared from the science perspective. We know they can pick up vibrations, and quote, "hear" in a different sense than you and I can hear. But then I also just do regular Google searches, which almost always comes up with the beekeeper answers, the forums, the anecdotal reports, like I talked about a little earlier with bananas. There was one interesting story about, can you play certain music types to get your bees to come forage in your yard? I can't say this without giggling but the title of that one is "My music brings the bees to the yard."

Amy 52:19
We need to play that song on the podcast.

Jamie 52:20

I'm not going to sing that title to you. But it was "My music brings the bees to the yard."

Amy 52:26
There you go.

Jamie 52:26
So there you go. That's what I was saying.

Amy 52:29
You know what though, Jamie? There are listeners that listen to our podcast while they're keeping bees. And I'm sure those bees are super happy because they can hear our voices and they know that that person's listening to Two Bees in a Podcast.

Jamie 52:41
Well, if you're a bee listening to me right now, you really need to do your best to help your beekeeper help you maximize your productivity, work hard, stay strong and healthy. And you too can be a good colony. And give your beekeeper some love and we'll go from there.

Amy 52:58
Your motivational speech to the bees.

Jamie 53:00
I've never spoken to -- I've never given a speech to bees before.

Amy 53:04
Alright, so the second question. So we've always heard that the smell of bananas is the same as a danger pheromone in a colony. And so the person is asking actually about the feeding bananas to bees. So is there any science on actually feeding bananas to bees?

Jamie 53:25
Never had this question before. So I do know that when the word banana and the words honey bees are mentioned in the same sentence, it's usually from the perspective that one of the components of honey bee alarm pheromone is a component that helps bananas smell like bananas. So people are always concerned that if you eat a banana before you work bees, you might cause those colonies to be more defensive. And in reality, there's never been shown to be a link before between the two. I don't recommend you smear yourself in bananas when you work colonies, but it's okay to eat bananas when you work bees, but this particular question is the first time I've ever been asked, "Well, can bees eat bananas?" Now, I've never heard of this at all. But I will say I did look it up online and I think I found the article that essentially drove this questioner to ask this question. The author of the article is basically making the point that on beekeeping forums every few years, beekeepers talk about the benefit of feeding bananas to their bees, especially during winter because it helps with X and it helps with Y and it helps with Z and it controls this disease and that pest. And, well, that's probably bananas. Boom! Had to get that joke in. But there's no research at all that I could find on feeding bananas to bees. Nothing at all. So while I am not surprised that people have tried it and have actually fed it to bees, I will say none of it's science-based, it's all anecdotal, and probably doesn't have much merit. But as a scientist, I will

always leave myself open to the possibility that something like this can be very beneficial for bees. But right now, there's no science to support it. It looks like just one of those things people have tried. But beekeepers have tried thousands of things. And I would argue if it really worked that well for everybody, everywhere, all the time, then we would know about it, and we'd all be doing it. So I wouldn't feed bananas to my bees.

Amy 55:39
Okay, so for the third question that we have, this person wants to produce honey off of 10-frame nucs and, and what's funny is that when I read that, I was like, "Isn't a 10-frame nuc just a regular hive?" But then I realized, no, they have a nuc, and then they have a five-frame nuc box on top of it. And so they're wanting to produce honey off of this nuc, and they want to know, how would they know about their local pollen and nectar flows? And so I'll let you take it from there. What should they do? And how would they know?

Jamie 56:11
Yeah, so let's first of all start with this whole nuc thing. So they do mention a 10-frame nuc. And if you think about it one way, if it's just one box with 10 frames, then it's not really a nuc, right? It's a full-size hive. But you can have nuc boxes that are five-frame nuc boxes. And so you will stack up two five-frame nuc boxes, which will give you 10 frames. So my guess, based on the question that's coming in, my guess is that's the configuration of this nuc, that it's actually two five-frame boxes, one stacked on the other, which gives you that kind of 10-frame. And then that's your basic hive, it's your basic hive configuration. That's how this beekeeper has elected to move his or her hives forward. Now, you can produce honey on hives like this, they make five-frame medium supers so that's very possible. But the catch about 10-frame nucs, in this particular case, is that because they're not very wide, they're not very stable. So they're stable at a box or two or three. But if you're having to stack multiple supers on top of two already stacked five-frame deep boxes, it's getting very tall, and top-heavy. So wind and vibrations, a lot of that can be a problem. So if you're keeping a 10-frame nuc, I would just recommend moving it up into a 10-frame, single deep box and then supering from there for honey production. So that's one comment. The second comment was specifically, though, the one that I think absolutely is an important one to think through. And that's essentially, how do I discover local flows? How do I know if I'm living in an area where honey is very available? Or what do I need to know about what my bees need from the honey perspective? So what I always say is you can't really know if you're living in a very good area for producing honey until you've lived there for three years. Because if the first year you produce a ton of honey, you might say, "Oh my gosh, this is such a great area." But then in reality, it was a bumper year and that's the exception rather than the rule. The converse is true as well. Let's say that you live there one year and make no honey at all. So you completely write it off and say this area's terrible, but it could also have been a drought, some sort of problem with the plant that you're targeting, etc. Years two through five could have been great. So it takes about three years to say this is a good area or a bad area. So number one, you got to wait a little bit. Number two, you really need to speak to other beekeepers in your area. Other beekeepers in your area provide absolutely the best information available about the nectar flow in that area because they've been there, they know. This area is pretty good, this area is not so good. I've used this example before on the podcast, before I moved to where I live in Florida, I was talking to a commercial beekeeper who told me that our area where I was going to move is terrible for honey production. In fact, secretly, I laughed my head off inside, not to his face, I laughed my head off inside thinking, I can make honey anywhere, and when I got here, it's a terrible

area. So he was right. But you got to ask other beekeepers because they know the area well. In my particular case, this individual could say, "Jamie, where you're moving is not so great." But what you produce in this area is from these three plants, and in order to get this plant, you need to go 20 miles north. In order to get this one you've got to go 17 miles east or whatever. He could not have only told me that it was a bad area but he could also tell me what direction I need to head to get into stands of the plants I needed to target. So if you want to know about local flows, you absolutely have to work with local beekeepers who've been there. The final piece of advice that I've given on this podcast before because someone's even mentioned it to me after the podcast was over, so I know I've said it, is find out what the main nectar plants are in your area, number one. Number two, go find those things at some local plant nursery, buy them, and then finally, plant them in your yard because then they become your botanical calendar. You can say, just to use an example where I live, gallberry, I know that gallberry's around me, but it's not in my yard so I'm not sure when the bees are going to need to be supered for gallberry. Well, if you buy some gallberry and plant it in your yard, you'll see the plant developing, you'll see the buds come on. And when the buds get very big and they're about to open, you can know the nectar flow's right around the corner. And when the buds are open, you can know the nectar flow is happening. So I'm a huge advocate of planting in your yard what's important to your bees in your area, not because you're going to produce so much honey from those few things that you plant in your yard, but more so you can have a botanical calendar to help you know when the flow is happening in area. And I especially like this idea if your major nectar plants are native plants like they are here for where I live in Florida. If invasive plants, highly invasive plants are part of your major nectar flow, I would not recommend buying those and planting those in your yard. But if native plants are, they make great yard plants anyway. But it's also a great botanical garden. So I set a lot of stuff to essentially say you've got to live in an area for three years, you need to talk to all the beekeepers you can find in your area about the nectar flow. And then finally, whatever it is that's important to your area, plant it in your yard so you can have that real-time calendar of how things are progressing.

Amy 56:21
Right. Yeah. And Jamie, you put together the beekeeping management calendar in Florida. And I would challenge even some of our Florida beekeepers here to take note of what is blooming in the area during certain times and compare it to our calendar because that's how we, a lot of times, stay up to date with these materials. And so if you're finding something that is in bloom, that is not invasive, and it's not on our calendar, let us know so we can update our content. And then the other thing, Jamie, working with your local extension office, there's usually a horticulture extension agent that also typically knows what is in bloom during certain times a year. So I encourage you all to work with your local county extension office if you can or your local garden association, wherever, whoever that may be.

Serra Sowers 1:02:45
Thank you for listening to Two Bees in a Podcast. For more information and resources on today's episode, check out the Honey Bee Research Lab website at UFhoneybee.com. If you have questions you want answered on air, email them to us at honeybee@ifas.ufl.edu or message us on social media at UF honey bee lab on Instagram, Facebook and Twitter. This episode was hosted by Jamie Ellis and Amy Vu. This podcast is produced and edited by Amy Vu and Serra Sowers. Thanks for listening and see you next week.