

MULCH MATTERS EP. 27

From Macro to Micro: Following Mulch Fragments Through the Soil

[00:00:00] Nataliya Shcherbatyuk:

Hello and welcome to the Mulch Matters Podcast where we will explore the intriguing world of mulch and its impact on agriculture and the environment, as well as update you on the latest research about soil biodegradable mulch and recycling options for plastic mulch. I am your host, Dr. Nataliya Shcherbatyuk, and I am a communications specialist for the project, "*Improving end of life management of plastic mulch in strawberry systems.*" In each episode, we'll dive into the latest research, trends, news, and insights on why mulch matters and how we can improve plastic mulch end of life options. We'll also branch out and discuss other plastics as well as talk to researchers, experts, and practitioners in the field who will share their insights and experiences on how to use mulch effectively in different settings.

[00:01:06] Nataliya Shcherbatyuk:

Hello, hello, and welcome back to another episode of Mulch Matters podcast. And our guest today is Xueyu Zhou from Washington State University. Let's welcome her. Hello. Hello, how are you?

[00:01:23] Xueyu Zhou:

I'm good. How are you?

[00:01:24] Nataliya Shcherbatyuk:

I'm doing good. I'm doing good. So, you know what, before going to the podcast details and biodegradable mulches we'll be talking about, I really would like you to introduce yourself to our audience. Who are you? Who are you, and what are you doing in our project?

[00:01:46] Xueyu Zhou:

Thank you Nataliya. My name is Xueyu Zhou, and it's a pleasure to be here and to share some of the work our team has been doing. And I'm currently a PhD student at Washington State University. Before coming to the U.S., I completed a four year undergraduate degree and then a two year master's degree in soil science in China. I continued that path here in the U.S. as well. I realized then that I have a real passion for soil science. I have been studying it since I was 18 years old, and I only still see myself staying in this field for many years to come. And during my PhD my research looks at degradation of bioplastic and tracking those smaller micro and even nano plastic particles transported in the soil.

[00:02:11] Nataliya Shcherbatyuk:

Oh, that's pretty interesting. And during our podcast we do talk a lot about soil, about degradable plastic mulches, about different types of mulches, about soil health and more. But I wanted to see if you can tell us why biodegradable mulch is being studied in strawberry fields?

[00:03:05] Xueyu Zhou:

Yeah. So why do we choose strawberry fields for this research? Because strawberries are grown very intensively and they rely heavily on mulches. In fact, strawberries are one of the largest users of plastic mulch in the U.S.. The crop is produced across many different regions, and its long growing season really demands good soil protection and effective weed control. All of this makes strawberries an ideal system to test how biodegradable mulches behave under real commercial conditions. If these materials can perform well in a crop that uses mulch so heavily, that's a strong sign they could work for many other crops as well. So those are the reasons why we chose strawberries.

[00:03:59] Nataliya Shcherbatyuk:

That's pretty interesting. And it's really nice that you mentioned that strawberries are an ideal crop, but actually the results you would be getting from the strawberry studies can be used in different crops as well. Yes. So that's very positive about that. And you mentioned that your team is investigating basically mulch fragments after tillage, right?

[00:04:23] Xueyu Zhou:

Yeah.

[00:04:25] Nataliya Shcherbatyuk:

So, can you explain a little bit how you designed your experiments, just to track those mulch fragments in the soil?

[00:04:36] Xueyu Zhou:

Yeah. When we set up our experiment we planned to track mulch fragments in the soil. We designed a multi state field experiment across four different states in the U.S.. They are Washington, Nebraska, Florida, and California. At each site we established strawberry plots with rows that were covered in plastic mulch. We compared three mulches: a conventional polyethylene mulch, and two different types of the soil biodegradable mulches made from PBAT blended with PLA or with starch.

We collected mulch fragments before and after tillage. Since strawberry seasons and field operations differ in each state, our sampling days also varied, but the experimental setup stayed consistent across all sites, which allowed us to compare how mulch behaves under different climates and soil conditions. And until now we already have the dataset from 2023 to 2025. And we are looking forward to maybe more data or figures in the future. Yeah.

[00:05:52] Nataliya Shcherbatyuk:

That's exciting. That's very exciting. And for our audience and me, can you please walk us through that sampling process when you actually go into the field? What does it look like in practice when you are actually in the field collecting those fragments in the soil?

[00:06:11] Xueyu Zhou:

In the field the sampling process is actually pretty hands on. We placed a one square meter wooden frame on the soil to mark our sampling area. We start by collecting all of the visible mulch pieces by hand. Then we mix the top 15 centimeters of soil inside that square using shovels, rakes, or weed hoes. We focus on the top 15 centimeters of soil because that's where most of the mulch ends up after tillage when farmers mix the film into roughly the upper 10 to 20 centimeters depending on the machinery. And the top 15 centimeters is also the most biologically active part of soil where microbes, roots, and moisture are concentrated. So, it's where most of the degradation actually happens.

And back to the sampling: once we turn the soil over, more fragments become exposed and we pick those out as well for further analysis in the lab.

[00:07:23] Nataliya Shcherbatyuk:

And when I'm imagining you in the field collecting the soil samples and then you look for the fragments, I'm pretty sure you meet a lot of fragments of different sizes. And in that case, why do you think it's so important to actually distinguish between microplastics and microplastics? And can you just give us a little bit of what you would consider microplastics and microplastics?

[00:07:49] Xueyu Zhou:

That's really a good question. It's really important for us to distinguish between microplastic and microplastic because the two behave very differently in the soil. For microplastics, which are pieces larger than 5 millimeters, they are fairly easy to see and collect. And they also tend to degrade a bit faster because their larger surfaces can attract microbial activity. So, in many ways they are the more straightforward part of the story. For microplastics, however, it is much more complicated. These smaller pieces can move through tiny soil pores, be transported by water, or potentially interact with soil organisms in completely different ways. Some studies even suggest they might travel deeper into the soil profile or into nearby waterways. Their environmental risks are less visible and harder to predict. So by separating mulch fragments into these two categories, we can get a clearer picture of what's really happening after biodegradable mulches are tilled into the soil.

[00:09:08] Nataliya Shcherbatyuk:

Interesting. It's like there is a separate life over there under the ground that we don't know about. And now if you think about, and you probably already saw that, so you can talk about that—if we imagine, let's say one year after or so, or more years, how have those fragments changed and what does that tell actually for us about the degradation process?

[00:09:37] Xueyu Zhou:

Yeah, about one year after tillage we definitely saw a clear shift in both size and the number of the mulch fragments. Many of the large pieces we found earlier had become thinner, more brittle, or had broken into smaller fragments. We also recovered fewer pieces overall. I think that means the microbes have been actively degrading the materials throughout the year. But it's important to note that not everything disappeared. Some fragments were still present, especially in cooler or drier parts of the field. But the general trend showed steady progress toward breakdown. When we compare these to what we observed right after tillage, it becomes clear

that degradation is a gradual process, and the mulch starts out as big noticeable pieces and over time, after one year, those pieces shrink, crack, and fragment as microbes continue working on them.

[00:10:47] Nataliya Shcherbatyuk:

Wow. That's definitely interesting what you're doing. And how about when you, for example, maybe observed—since you mentioned that you're working in different states, the project covers different states—have you observed any changes if, let's say, we're talking about different soil conditions or locations of your experiments? What was something interesting between that?

[00:11:12] Xueyu Zhou:

Yes, we saw some pretty clear differences in how mulch fragments persisted depending on the soil conditions and the locations. Like you said, we collected samples from different states. What's interesting is that we originally expected warmer temperatures and higher moisture to show faster degradation. And that condition seemed likely in places like Florida, right? But surprisingly we actually saw faster degradation in Washington than in Florida. One possible reason is that the soil in Washington is loamier, so it holds moisture more effectively and supports a more active microbial community. Those biological and physical conditions really help drive the breakdown process.

And I think this also tells us that degradation isn't uniform even when the same mulch is used and the same tillage practices are applied. These materials interact very closely with the soil environment, and factors like local climate, soil texture, and microbial activity all play a major role in how quickly they decompose.

[00:12:35] Nataliya Shcherbatyuk:

That's very interesting. Yeah, that's definitely exciting. I'm just thinking about how many things, results you see. And so, if you would be talking to farmers right now and based on the findings that you already have from your experiments, what would you tell them to consider when they think about soil degradable mulch as the alternative to PE mulch?

[00:13:06] Xueyu Zhou:

Yeah. At the moment I would say approach them with both optimism and realism. These materials can offer real benefits, but their performance depends heavily on local conditions. So rather than assuming they will behave the same everywhere, I encourage people to start small, gather data from their own fields, and make decisions based on what they observe. With thoughtful adoption and good science guiding the process, these materials can be an important step toward more sustainable agriculture.

[00:13:47] Nataliya Shcherbatyuk:

Okay. And while you are on the topic talking to farmers, are there any limitations that you think they should be aware of when adopting biodegradable mulches?

[00:14:00] Xueyu Zhou:

Yes. There are a few practical limitations to keep in mind. Firstly, not all biodegradable mulches are created equal. Different formulations break down at different rates and performance can vary depending on

soil conditions. Second, degradation takes time. Farmers shouldn't expect the mulch to disappear immediately after tillage. It can persist for months or longer before fully breaking down.

Cost can also be a consideration, since BDMS are usually more expensive than traditional poly mulch. And I think finally, because these materials are still relatively new, some regions may not yet have clear guidelines or standards for their use.

[00:14:56] Nataliya Shcherbatyuk:

Yeah. And thinking a little bit ahead of time, what future studies would you like to see to better understand the long term effect of biodegradable mulch? Basically, we discussed earlier today with you, but also in previous podcast episodes, that fragments are staying in the soil and like you mentioned, after a year or so not all biodegradable mulch fragments were gone. So, it's still taking a little bit of time for them to biodegrade, to finish the process of biodegradation. So what do you think of interesting studies in the future would be quite helpful for better understanding the long term effect of this mulch?

[00:15:45] Xueyu Zhou:

One big priority is following these materials for many years, not just one or two seasons, to see how completely they break down and what kinds of intermediate fragments appear along the way. And our multi state study has already shown that environmental conditions matter a lot. I think it's also important to scale that up to more regions and more cropping systems. I think that would help us build much stronger predictions.

[00:16:23] Nataliya Shcherbatyuk:

Yeah, research usually does take more than just three, four years to get any assumptions on the long term benefits. And what if you could give one piece of advice right now to farmers or policymakers about biodegradable mulch, what would it be?

[00:16:43] Xueyu Zhou:

I was thinking like, there's no one size fits all solution for bio mulch. So, when you start to use it, think about if it's suitable in your field, in your site, and how long it will take to break down. Think about those limitations we just talked about and let it be more sustainable materials.

[00:17:06] Nataliya Shcherbatyuk:

That's a good one. And tell me what excites you most about the future of sustainable mulch technologies and also about the project you're doing every day.

[00:17:20] Xueyu Zhou:

I think there's been a lot of excitement around BDMS and also quite a bit of uncertainty about how completely and how quickly they break down under real field conditions. There are a lot of important questions because biodegradable mulch is being promoted as a more sustainable alternative, but its environmental performance really depends on what happens after incorporation. From my side, I think our team's motivation is to bring clarity by showing not just the potential benefits of these materials, but also any limitations or environmental factors that might influence how they behave in the real world.

[00:18:09] Nataliya Shcherbatyuk:

That's very thoughtful, I'm gonna tell you. Yeah, I thought you were gonna say I'm excited about publishing papers, meeting new people, but you're actually talking about very, I would say, deep topics and deep thoughts, which is very interesting but also very important.

[00:18:26] Xueyu Zhou:

That probably is also one of the most exciting parts.

[00:18:31] Nataliya Shcherbatyuk:

Yeah. Sure. Thank you so much. I think it's been quite interesting. And I will also provide some information on where our audience can find more of your study results. We do have a newsletter, and I believe you have an article in it. So that would be interesting to read as well.

[00:18:50] Xueyu Zhou:

Thank you so much, Nataliya.

[00:18:56] Nataliya Shcherbatyuk:

That's it for today and until the next episode. You can find more information by following us on Instagram and LinkedIn at @mulch_matters and going to our website <https://smallfruits.wsu.edu/plasticmulches/newsletter/> and choosing *Mulch Technologies*. This work is supported by Specialty Crops Research Initiative Award 2022 51181 38325 from the USDA National Institute of Food and Agriculture. Any opinions, findings, conclusions, or recommendations expressed on this podcast are those of the author(s) and do not necessarily reflect the view of the U.S. Department of Agriculture.

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