Digging Deep: Microplastics, Soil Health, and Sustainable Agriculture with Nayab Gull

[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 system”. 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.

[00:01:04] Nataliya Shcherbatyuk:

Welcome back. I'm so excited to have Nayab Gull on our podcast today. Nayab is a PhD student at Washington State University. Her research focuses on microplastics and soil health. Let's get started and hear more about her work. Hello, Nayab. How are you?

[00:01:30] Nayab Gull:

I’m good, Nataliya. How are you? Great to hear you.

[00:01:33] Nataliya Shcherbatyuk:

So, I am anticipating quite interesting conversation today, but before we go. And dig deeper in microplastics. That's what we going to be talking today. How about we start with you? Uh, can you tell us a little bit about yourself, about your background, basically, who is Nayab Gull and what's your role in the project?

[00:01:59] Nayab Gull:

Yeah, so, my name is Nayab Gull. I'm originally from Pakistan. Um, grew up there, lived my whole life pretty much there. I did my undergrads there in agriculture, which was not something that I planned at all because I didn't have any prior interest in agriculture. I knew nothing about farming. In fact, I was planning to attend medical school. But that didn't work out. So, you can say, I switched to agriculture and it was way later that, you know, I became interested in learning more about food systems and agricultural

sustainability and just, you know, learn to enjoy what I was doing and having fun. And I think I came across some amazing opportunities along the way. For instance, I went to China for my master's degree, and then I came to WSU in summer of 2023 as a PhD student in the Department of Soil Science. And now I'm working, it's been almost two years with Dr. Deirdre Griffin LaHue and Dr. Lisa DeVetter, on the SCRI project. And my role on the project is to compare the horticultural benefits of soil biodegradable plastic mulch films or BDMs to conventional polyethylene mulch. And I'm also looking at the impacts of these different biodegradable mulch films on soil health variables. So, I think it all worked out.

[00:03:40] Nataliya Shcherbatyuk:

pretty well so far. Yeah. Well, it looks like you decided, you know, I'm not going to be a doctor for humans, but why not to be a doctor for plants and soil and, and all of that. Exactly. Hey, that's pretty cool, exactly. I, I feel you. Okay. But what inspired you to explore the impact of microplastics on plant soil system, and why do you think this topic is critical for sustainable agriculture?

[00:04:10] Nayab Gull:

Okay, so I think it really goes back to my master's research. So basically, I was looking at how the interaction of different types of microplastics and climate warming will impact soil and plant health. And it was really interesting because if you think about it, agricultural stressors actually coexist in the environment. So, I was really interested in knowing if they're going to, you know, microplastics and climate warming, are they going to exacerbate the effects of one another. So that kind of, really, got me interested in the topic. And I would say I've been hooked ever since. And I knew that I wanted to continue working in the same area. And I feel like it's very important because. Microplastics are now everywhere, most importantly in agricultural soils. And they're not just sitting there in the soil, you know, they've become a global change factor, which means that they have potential to impact individual organisms, populations, and then entirely, you know, ultimately entire ecosystems. So, we have some strong evidence too about, you know, microplastics exchanging soil and plant functioning. So, I feel that there is definitely a potential for them to put our food systems and sustainability at risk, given, you know, they persist in our environment and soil for a long time.

[00:05:45] Nataliya Shcherbatyuk:

Well, and speaking about microplastics, let's talk a bit in more details and can you explain. How different types, sizes and shapes of microplastics uniquely affect soil properties, like let's say water retention structure pH?

[00:06:09] Nayab Gull:

Absolutely. So, the diverse characteristics you mentioned because of these characteristics. They can have different impact on soil properties. Some effects that we observe across most of the types are, structural changes, like decrease in soil bulk density and aggregate formation. And the reason is that microplastics can create macro pores in soil. And it's not like the pores are not already present in the soil. They are for the movement of water and air, but addition of microplastics can increase the pore space. And so less water is routine in the pores and that decreases the aggregate formation as well. And that's not ideal because soil aggregates not only bind soil particles together, but they are also a habitat for microbes. So, we can't disturb that. And then coming back to the types. If you know, most plastics are hydrophobic in nature, meaning that they repel water. So, if you add them to the soil, they create localized dry zones and that can reduce water retention as well, which makes it also very difficult for plant roots to uptake the water. And lastly, when we talk about pH changes, they're truer for plastic polymers that have acidic properties, and they have the ability to leach these, you know, acids in the soil. While they break down. For example, a good example for that is of that is, polyvinyl chloride or PVC. Um, when it breaks down in the soil, it can release hydrochloric acid. But again, the extent of this change really depends on, um, size, like how big or small the microplastics is and how much you've added to the soil, the concentration. And I feel that these impacts should be taken with a grain of salt because, it's very important to note that majority of these results are from lab experiments. Okay. You know, where we use rather smaller volume of soil with microplastics dosage, that's way too higher and size. That's way too small to be called environmentally relevant. And, I'd say as a student, I'm still learning, but I, I don't think that these results can be a true representative of what we see in the field conditions or in the real world. And, that's where, you know, we need more research to validate these findings.

[00:08:49] Nataliya Shcherbatyuk:

Yeah. And you know, not long ago you, um, you came out with the fact sheet, which is, by the way, our fact sheets can be found on our website and social media and newsletter, and I will provide all of that information at the end of the podcast for those who are interested. But let's. Look a little bit on the fact sheet that you, discuss, and what specifically I'm interested in is that you've been discussing the dual role of microplastics in enriching and disrupting soil nutrients. Could you elaborate on the circumstances under which microplastics might benefit all nutrient cycling?

[00:09:37] Nayab Gull:

That's a very good question. Yeah. There have been cases, you know, where it can happen. Um, but we can't say that it's a benefit. Mostly it happens because, microplastics, especially fibers have a relatively larger surface area than soil particles. Um, that makes them, you know, uh. That increases the chances to absorb or absorb nutrients and contaminants, so they have a higher tendency to release these. Absorb nutrients or contaminants in the soil over time. And in this case, I will only talk about

nutrients. So, when these nutrients are released in the soil, they can potentially become more available to plant roots. And another, another interesting reason is that microplastics can create new habitat or what we like to call ecological niches. For, um, soil microbes. So, um, then we see changes in microbial communities and increase in microbial biomass. And I wanna also point out that this increase in microbial biomass is generally true for biodegradable microplastics. Then the non-biodegradable ones because, micro's been soiled, can. Use biodegradable microplastics as a food source and so mm-hmm. They use them for their growth and development, and we see a higher microbial biomass and also increase in activity of some soil exo enzymes and. All of this can result in higher nutrient acquisition or what we can say, um, benefit of soil nutrient cycling, you know, but again, these are some predictable short-term effects and, um, eventually they can be potentially. Degrading to soil health. What we need to understand is that the direction of effect size doesn't matter actually. Even if you see an increase in a soil variable, for example, that doesn't necessarily mean that it's a positive effect. I feel like it should be viewed as an undesirable change in the system. You know, that wouldn't occur if the pollutant or microplastics, excuse me, microplastics was not present in the soil.

[00:11:57] Nataliya Shcherbatyuk:

Got it. Got you. That's pretty interesting. That's exciting. What you're doing is very exciting. And since you mentioned plant roots, let's talk a little bit about plant roots.So what do you think are the most concerning effects of microplastics on plant roots? And how might this, how might this actually affect, crop productivity on the long term?

[00:12:25] Nayab Gull:

Yeah. So, there can be some direct effects, like physical disturbance. It's a pretty common one that we see, and it can decrease root penetration and development. So. And then there is release of toxic chemicals or plasticizers. And, um, these plasticizer additives are added to plastics while manufacturing to give them certain functional properties. So, it's important to add them. Uh, but the, the risk is that this, these chemicals can leach in the soil when microplastics degrades or break down, um, especially if it happens near the roots, ri root zone or rhizosphere. They can, um, negatively impact the root functioning by disturbing the microbial interactions between plant roots and soil. Um, so then you'll see limited nutrient availability and poor plant development. And further, if you look into, nanoplastics, they've shown to get absorbed by plant roots and cause cellular damage. So, what I'm trying to say is that this, this would definitely put the crop productivity at risk in the long run, but. These are potential effects. And these cannot be generalized, you know? Right. We can't use them in a, in a, in a, you know, they're context dependent and we can't use them in a very generalized way. Um, they can vary depending on type concentration and, most importantly, climate conditions.

[00:13:58] Nataliya Shcherbatyuk:

Okay. Yeah, that makes sense. Hey, some fun questions for you. Well, I dunno if it's fun, but since you mentioned at the beginning that you wanted to be in the medical career, I just cannot pass and not ask you some. Human health related question. So, speaking about bio accumulation of microplastics in edible plant tissues, right? Because if they're being absorbed by the roots, they are obviously in the plant tissue and there are plants to be eat. So how significant do you think this issue is, and what does it mean for food safety and human health?

[00:14:43] Nayab Gull:

I really feel strongly about this topic, and let me tell you, in addition to direct consumption of the contaminated plants, microplastics can be transferred to human feed food chain indirectly, for example, um, through seafood, poultry, or even personal care products. So, um, in short, we are exposed to microplastics one way or another on a daily basis. And I mean, sure the dosage may be low, and we may not be able to see their adverse effects just yet. But, um, the question is how this chronic exposure to low dosage of microplastics in our diets does will impact our health and. Honestly, we really don't know because there are no current studies looking at this. Um, except for a few ex, in fact, I recently came across this report by, um, the California State Policy Evidence Consortium, Cal Spec. They're doing some excellent work collaborating with, if you don't know, they're collaborating, um, with the California State Legislature and they help the California State legislature. Make policy recommendations based on evidence, scientific evidence, and according to their report, um, the dietary exposure to microplastics was associated with di digestive, reproductive, and respiratory harm. So you can, you know, imagine how serious this issue has become, and obviously it'll have farfetched consequences for our food safety as well.

[00:16:32] Nataliya Shcherbatyuk:

And, you know, given the variability in micro plastics impact based on the environmental and experimental conditions, what recommendations that I cannot ask? Recommendations more like what do you think or what would you like to see for the future research in this field?

[00:16:54] Nayab Gull:

So, according to my limited knowledge as a student. I feel like we don't have enough studies on, you know, long-term assessments of microplastics and, um, there there's more emphasis on lab studies than field-based assessments. And we also need to, I think, acknowledge that field conditions represent a way more complex, system. Where, you know, multiple factors are interacting simultaneously. So we can't be certain on how different microplastics behave based only on con controlled studies, um, unless we are including multiple factors, you know. Looking at multiple factors and their interactions. So I think that

would be one thing and another area that I feel, um, I, I would hope to see more efficient detection methods and quantification methods, because sometimes it's so hard to compare results from two different studies because they use different quantification methods and I, I, mm-hmm. I do understand the limitations and, you know, in feasibility and. Uh, in, in also standardizing these protocols, but it makes it harder to objectively evaluate, you know, how, um, microplastics behave. So, yeah.

[00:18:23] Nataliya Shcherbatyuk:

Yeah, those are good points for sure. It's definitely not as easy as it might sound. To do any studies in the field, especially when you're working with soil, there are so many factors involved in there besides the soil type. It just like you mentioned, communities and, and even weather conditions and all of that. Yeah. And from the practical, standpoint, what steps do you think the farmers and policy makers they can do or they can take to mitigate the, the adverse effect of microplastics on soil plant system? This is a tough one.

[00:19:02] Nayab Gull:

if we were living in a perfect world, I would just say let's just get rid of plastic once and for all. But, um, that's not possible. So what we can do, at least, um, one thing is to minimize use of single use plastics. As much as we can. Mm-hmm. And, for farmers, if they're using biosolids or organic fertilizers, um, I would recommend just testing for PFAS and microplastics beforehand, before applying them into the soil. And, same goes for biodegradable mulch. Um, we need to understand that not all biodegradable materials are created equally and not everything in the market that's marketed as biodegradable. Is in fact biodegradable. So, we see, we see a huge, knowledge gap and, you know, that's where policymakers can help make this information on tested materials accessible to farmers. And, they can continue funding interdisciplinary research like our project. Yeah.

[00:20:10] Nataliya Shcherbatyuk:

And, uh. What is next for your research? Are there any specific questions or challenges you are excited to address regarding microplastics and agriculture setting?

[00:20:23] Nayab Gull:

Well, I can't say much right now, but um, yeah, I am looking forward to starting my new project very soon. And, yeah, this time we're looking at accumulation and uptake mm-hmm. Of microplastics and plant roots. So, yeah, I'm, I'm excited to share updates, um, when we talk next time. Yeah. Um,

[00:20:47] Nataliya Shcherbatyuk:

well, it definitely seems like you're enjoying your time in graduate school. So can you, can you tell me what is your most favorite part about grad school?

[00:21:02] Nayab Gull:

There are many things, actually, not just one, but I'm top three. Um, I think, I think just how well it prepares you for your professional life. I mean, the connection you make, the amazing people you get to work with, and that too with diverse backgrounds and the opportunities you get as a grad student, I feel there are so formative in so many ways and, um, I'll be lying if I don't mention the free food and travel that we, we can.

[00:21:38] Nataliya Shcherbatyuk:

Yeah, this is definitely a good time. Well, and it also opens to critical thinking. Definitely. Look, of course, look at the surroundings. Slightly different than before.

[00:21:47] Nayab Gull:

Yeah, of course. Yeah. You're a scientist. Yeah, it's a cool profession.

[00:21:53] Nataliya Shcherbatyuk:

Yeah. Yeah, definitely. Cool. Well, nev, thank you so much. I think it was the great information. Provided to our listeners. It's very interesting and again, I will provide all the links where you can find more details on the information we spoke about and the fact sheets and social media stuff that you can learn more about my microplastics that NayabYA is working on. Of course. Thanks so much for having me. Thank you.

[00:22:26] Nataliya Shcherbatyuk:

That's it for today and until the next episode. You can find more information by following us on Instagram and LinkedIn by @mulch_matters and going to our websites and choose 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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