From weeds to wisdom: exploring hydromulch with Greta Gramig

(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.

(00:01:02) Nataliya Shcherbatyuk

On today’s episode we’ll sit down with Dr. Greta Gramig, a plant scientist from North Dakota State University. Greta will bring her extensive experience in weed science and sustainable agriculture to the table today. She will discuss her innovative work on biodegradable mulches designed to enhance organic farming. Greta will also share insights from her academic journey at Montana State University and the University of Wisconsin-Madison, as well as her practical experiments with mulching techniques that could potentially transform environmental management in agriculture. Thank you again so much Greta for joining us today and let's dive in. So how about you start by telling us a little bit about yourself and what brought you to working with mulches.

(00:02:03) Greta Gramig

Yes, my academic background is in plant science with an emphasis on weed science and I completed my Bachelor of Science degree at Montana State University and then I went to the University of Wisconsin-Madison to obtain my Master's and PhD degrees and I

always, even before I was doing this academic work, I had an interest in growing plants and gardening, and while I was at Madison I got interested in mulches not because of my research, but because of a couple of different experiences. So I grew many gardens while I was in graduate school and I was gardening in student community garden plots and there was a neighbor next to me who was growing nothing but raspberry canes, and her plots were super infested with Canada Thistle and field bindweed and if you know anything about those weeds they're perennial weeds that can creep clonally and they were always creeping into my garden, so I started experimenting with fabric weed barriers, and I also would do cut-and-carry mulch using other weeds that were growing around me because a lot of the gardens were super weedy. So, that was one experiment that I did with mulches, and then I also tended a garden with a friend on his mom's farm and it was a little farther from Madison, so we couldn't go there very often, and we would plant everything on Memorial day and then we would do the cut-and-carry mulching with giant ragweed cuttings and mulch it really heavily, and then we would just leave it until fall harvest. And there were certain crops you couldn't grow this way, but a lot of crops we could grow just heavily mulching them and we never did another thing. We just came back in the fall and got our harvest/ So these experiments really showed me how affecting mulches can be. And also, another thing that kind of feeds into the topic for today: I'll always remember having a conversation out in the field with one of my weed science mentors and he told me about some experiments that had been done to test spray on foam barriers in annual cropping systems. And something about this really caught my imagination and I would always think about it years later, and so when I was hired at North Dakota State University to do weeds research, one of the areas I started working in was using mulches especially for horticultural production.

(00:04:56) Nataliya Shcherbatyuk

And was it specifically for organic purposes or any horticultural production?

(00:05:02) Greta Gramig

Some of the studies were not specifically organic, but some of them have been. It turns out that you know who are the people most interested in funding that kind of research, they're usually people that are funding organic research. So, a lot of my funding has come from ah groups or agencies that are specifically funding organic research. But that being said, these techniques are not exclusive to organic production. They can definitely be used in non-organic production, and many of them are you know of course plastic mulch is widely used in both types of systems.

(00:05:40) Nataliya Shcherbatyuk

Yeah, I see, and actually bringing back our conversation to organic horticulture, can you please share with our listeners a little bit about current reliance on organic horticulture producers on non-biodegradable plastic mulches and the challenges which are associated with their disposal?

(00:06:02) Greta Gramig

Yes, organic horticultural producers are very heavily reliant on using non-biodegradable plastic or polyethylene mulches [PE]. And they use them because these mulches suppress weeds very well, but they can also help modify the soil microclimate to benefit crop growth, and these mulches are relatively inexpensive and easy to use and install, using you know mechanized equipment. But in organic systems the rule states that the mulches have to be 100 % removed from the system and that ends up being pretty difficult because you'll have soil and plant matter that's adhering to these films. They're also really thin and fragile so they will fragment into pieces and so the adhered material makes the plastic heavy and difficult to move to dispose of it and the fragments mean that it's very difficult to remove it 100 % from the field. So, the disposal is difficult and costly.

(00:07:21) Nataliya Shcherbatyuk

Yeah, and talking back about non-biodegradable plastic mulches, let's talk a little bit about the environmental concerns which are actually arising from the use and disposal of these plastic mulches. Would you like to expand on that a little bit?

(00:07:41) Greta Gramig

The problem is mostly that the non-biodegradable plastic fragments contribute to there is disposal costs, but there's also societal costs associated with these mulches because they contribute to the plastic pollution problem. They break down into smaller and smaller pieces, but they're never really decomposed by the soil microbiology and there are growing concerns about the impacts of these plastic fragments that are polluting almost every ecosystem on Earth.

(00:08:22) Nataliya Shcherbatyuk

Yeah, and we do talk a lot about plastic pollution in our podcast; and talking about National Organic Programs which is NOP, most people hear it like that. They have specific requirements for organic mulches, it can be basically accepted into organic horticulture. Would you mind telling us a little bit more about availability and actually current challenges which are associated with this commercially available by degradable plastic mulches or we call them BDMs?

(00:08:58) Greta Gramig

Yeah, BDMs for short. Well these have been around for a while, they've been commercially available since the 1990s and in October of 2014 the USDA National Organic Program added BDMs to their list of allowed substances. So technically they are allowed, but right now there aren't any commercially available BDM products that meet their requirements. So, they've got four different requirements. One is that the BDMs need to meet compostability specifications that follow at least one standard and there's a bunch of technical standards that you can see in the rules. So, the material needs to biodegrade

to a certain level according to one of these standards and it needs to demonstrate that there's at least 90% biodegradation in the soil including some other standards. So, there's some standard procedures that are used to test this and, moreover, the BDMs are supposed to be produced without using organisms or feedstock materials that are derived from excluded methods and that could be things like it contains materials that originated from genetically modified organisms or something like that. It also must be 100% bio-based content and with the exclusion that certain minor additives are not required to be bio-based. But 100% or nearly 100% bio-based content. And the problem is that there aren't any BDMs that meet these standards and so they can't be used in organic agriculture the way the rules are written now. And then another thing there's also research that's been conducted under field conditions that has shown that even though people claim these are biodegradable, the mulches can remain in the field soil and for a long time, and not much research has been done to determine possible impacts of BDM decomposition on various soil properties including soil biology. And organic farmers tend to be concerned about soil impacts of various practices. So we really need to do more research about what actually happens to these BDM films when they go into the soil. The idea is that you unlike the non-biodegradable films you just till those in and they're supposed to biodegrade.

(00:12:06) Nataliya Shcherbatyuk

Right, yeah, that's correct, definitely more research needs to be done to investigate what is going on. And I'd like to take you back to your research that you're working on. So, tell us a little bit about what is the long-term goal of your research and I'm talking about this developing cellulose-based hydro-applied biodegradable mulch and what is different about this type of mulch and already existing alternatives.

(00:12:41) Greta Gramig

Ok, because of the problems I just described and the virtual prohibition of BDMs, organic producers who are concerned about plastic use and waste need alternatives. So, you

know, organic agriculture is sold as being kind of “green” and yet using all this plastic really isn't a very green practice, and so we've been working, I've been working with collaborators in Montana, Washington State and Oregon State, and also with the USDA in Minnesota to develop and test what we call hydromulches, and they're based on cellulosic materials. So, the idea is that you mix a slurry out of some cellulosic feedstocks and some other materials that act as tackifiers or glues, and then you spray it on the soil surface. So, this is not a new idea, and several research studies have investigated hydromulching as a method to suppress weeds and also to protect or enhance crop yield. But none of these studies that I'm aware of have focused specifically on the particular requirement for U.S. Organic certification. And that's why I and my collaborators applied for funding from the USDA NIFA Program Organic Research and Extension Initiative or OREI for short and this is the USADA’s flagship program to support specifically certified organic agriculture and farmers in the U.S. And so unlike many of the previous research studies about hydromulches our formulations and other associated practices we're designed devised specifically to meet the requirements of U.S. Certification and we're specifically testing them on certified organic land. For instance, one issue that came up is: U.S. organic rules allow the use of newsprint paper which is one of our feedstocks for hydromulch, but it must have recycled content, therefore we're using 100% recycled newsprint paper instead of say virgin newsprint as its majority feedstock in one of our hydromulch formulations. And then another example is the choice of tackifiers. So, these ta tackifiers are gluelike components that are added to the feedstock at low quantities, but they add cohesion strength and durability to the hydromulch and a lot of times these kinds of compounds are proprietary or they're synthetic and there's no way that you could get them certified. But we use things that are specifically accepted by certifiers. And so these are some examples of how our formulations were designed to specifically address organic horticultural production in the U.S.

(00:16:05) Nataliya Shcherbatyuk

That's pretty cool, I am learning a lot. So, definitely it will be benefiting organic horticulture producers and if we speak about overall society at large, do you think or do you have any information to say about economical beneficial and environmental beneficial overall?

(00:16:28) Greta Gramig

Yeah, well I think we already touched a little bit on the environmental impacts of plastic pollution. But I have a little bit more to say about it. These fragments break down and they are causing microplastic pollution which we're learning more and more about how ubiquitous it is. I think I saw a report that came out just a couple weeks ago about some water samples, I think they were commercial bottles of drinking water that contain millions of these fragments, and we have no idea the far-reaching impacts of this microplastic pollution. But there is some research about it and research has indicated that microplastic exposure can pose potential health risks to humans and also to every other living organism. But in regard to humans these include respiratory and digestive problems, disrupting sleep, contributing to obesity and increasing the risk of diabetes, and this is probably just scratching the surface. As research in this area is very new and we need a lot more research in this area. So, consequently even though the use of plastic films provides many economic and production benefits there are economic externalities associated with its use and so for people who haven't studied economics there's an idea that there are external negative externalities which are indirect costs that are caused by producer, but they're not the cost isn't incurred or born by that producer but rather those costs are imposed on some outside entity, often society at large and this is classic. Most pollution is a negative externality and so these plastic mulches contribute to plastic pollution that probably has and will have substantial health impacts that have costs associated with them, but these costs are not born by the plastic polluters and therefore use of biodegradable mulches while the product itself and using it will probably be more expensive than using plastic mulches, it will reduce these negative externalities caused by the use of plastic mulches. But the question is, this is complex, because how are you going to get the cost benefit to the farmers to make it worth it to do this. Would they receive subsidies for playing a role in reducing microplastics to balance their added

production costs? This would be kind of analogous to receiving carbon credits, for example, there's an idea that farmers could receive carbon credits for certain practices like cover cropping, or maybe alternatively just like consumers are willing to pay more for organically produced fruits and vegetables, would they also be willing to pay more for produce that was produced without these plastic mulches? Maybe you could have some kind of added certification or a label saying “plastic free” you know, and I've actually seen this on some products that I buy, not produce but other things where the manufacturers are and the companies are claiming that they're producing kind of a plastic neutral product because of the way their practices are designed. And so again, you know, just because organic agriculture often promotes this image of greenness or environmental responsibility and carrying the use of all these plastics seems to go against that image and I think that reducing non-biodegradable plastic mulch use as well as reducing other agricultural plastics of which there are many, like, drip tape and stuff like that, would have clear environmental benefits. But how growers would be impacted economically is uncertain because I'm pretty certain that the way they're doing things now is the most economical and gives them the most profit. But that being said as part of our project we are conducting very comprehensive economic analysis to compare the cost of using plastic films, non-biodegradable plastic films versus our hydromulch formulations and so when the study is more complete, we'll know something about just how much more expensive it will be to use these hydromulches instead of non-biodegradable plastic. I'm pretty sure it's going to be a little bit more expensive but maybe it's not much and maybe the margin would make it worthwhile if you could have some kind of “green” or “plastic-free” label on your product.

(00:22:13) Nataliya Shcherbatyuk

That’s great and you actually answer the question that arose in my head. I was going to ask you if you are collaborating with any economic team which you just said that, so that's great, and I wanted to then chat to you a little bit about the weeds. So, you touched a bit about hydromulches, they used before, and they've been suppressing weeds but in your

current research and study do you use any specific criteria how do you assess the weed suppression and soil health as well?

(00:22:51) Greta Gramig

How do we measure it, we did some more controlled studies where we applied these mulches in small trays in the greenhouse and that's how we and with weed seeds planted in the soil underneath the mulch just like they would be out in the field, so we did some small tests in the greenhouse to pick out the most promising formulations and then we did field studies, where we applied the hydromulches to raised beds and we also have other treatments that consist of plastic film mulches and also treatments with no mulch. And then we just count how many weeds come through those mulches. That's how we're assessing the weeds and so far our results show that the hydromulch formulations some of them suppress weeds rather well, but none of them suppress weeds completely and usually, unless something like animal damage or machinery damage causes a hole in this plastic film mulch, those mulches are going to probably suppress the weeds almost 100%. We've also seen that certain weed species such as sedges or grasses are harder to suppress in the hydromulch because they are unlike a dicot weed will emerge with a single coleoptile leaf. That's kind of like a little needle and it can easily pierce or find a small hole in that hydromulch. So there's a little bit of difference among different weed species in terms of the efficacy of suppression, but interestingly even though the hydromulches tend to allow some weeds to emerge and grow we often see that our crop yield is not really impacted or maybe it's just reduced by a tiny little amount, and we also haven't really shown any impacts of using hydromulch on fruit or vegetable quality or plant leaf nutrition in relation to the standard plastic mulch, So, I think that we can still also make more progress on suppressing weeds better by tweaking the formulations, maybe we can adjust our application rate, our mixing procedure and the application methods. So, the hydromulches are applied as aqueous slurries and you really need a very smooth slurry to be applied very evenly and consistently to improve the weed suppression, and I think that we could still improve this aspect of it and that's something that will require, you know, work that we can't really do. It's not really, it wasn't really a big part of the current

project, we were just hoping to, we were able to develop something that could do a pretty good job of applying it. But I think that we, because none of us are really Ag engineers, need some more work in that area. And you also asked about soil health, and we also, so especially organic producers, are going to be concerned, just like with the BDMs, they're going to be concerned about well what happens when you till this stuff into the soil and so a big part of the current project, which a lot of previous research hasn't really addressed was to collect a lot of data about how the hydromulches impact soil health, and because the material is mostly carbon, it's cellulose-based which is mostly carbon. Decomposition of these hydromulches could impact soil microbes via altered soil carbon to nitrogen ratios, for instance, and adding organic matter to the soil can change a lot of different chemical and physical soil properties. So, we're going to be measuring a lot of those things, in about a year we'll know a lot more, right now we've collected one year of data, I don't think any of it the samples haven't been processed yet fully, and we don't have our data yet. So, we still don't have answers, but we're working on it.

(00:27:52) Nataliya Shcherbatyuk

And yeah, that's great, and I have a question about actually the application, just for me to understand and for our listeners as well. So, when we're talking about the application for hydromulches, is that something we apply once in the season or do you think, let's say if there is a spot where a hydromulch got destroyed or something, can you just go back a little bit later and basically spray it over it again?

(00:28:22) Greta Gramig

Yeah, that's an interesting question. We haven't done that because we wanted to test specifically justifying it once, and so it does last all season most of the formulations, if they have a tackifier. We had a formulation that was paper only without a tackifier, that one is less durable, but if they have tackifiers then they just generally last till the end of the season, and to some extent they'll still be there the next spring if you don't till them in, but you could in practice cover little holes with a smaller handheld applicator. It would be

kind of analogous to, you know, doing the majority of your herbicide applications, using a field scale, large applicator and then going back with a spot sprayer to kill weeds here and there, you'd have to have two different equipment types. But for the initial, so I did another project before this one where we had really small application system that was just based on a backpack sprayer and you could definitely use something like this to apply patches, but I think that in general for larger producers they probably wouldn't have the labor to do that, so we're really focused on just doing one application at the beginning of the season.

(00:30:01) Nataliya Shcherbatyuk

Well, yeah, and it's a great start definitely to see how long it last, because you even mentioned it's going to last possibly to the next spring if you don't till it in and it's fantastic, I'm just trying to get through the questions to potentially might arise. If for example, if it's the cellulose-based hydromulch and it is damaging and people worry about weeds and then the question gets that what about now we need to do the herbicide. That's why I was thinking what if you just, you know, spot apply hydromulch.

(00:30:32) Greta Gramig

Oh yeah, sure, yeah, and it wouldn't be hard if someone had the time to do it, sure.

(00:30:40) Nataliya Shcherbatyuk

Yeah, because if you have the plastic mulch as a PE, for example, you just lay it and you cannot be patching the pieces, you know, if it's ripped off somewhere.

(00:30:48) Greta Gramig

Yeah, and then the other thing, people can do and I'm sure that they do this to some extent in organic production, any kind of mulch that you use is going to have weeds

growing in the planting holes and the hydromulch is no different, and obviously because those weeds are so close to the crop they are very damaging and so sometimes growers go through and remove all those by hand and that's something that we did in our studies, we removed the planting hole weeds because it's pretty quick and easy to do that and if you also had a few weeds emerging in other holes or other flaws in the mulch at that time you could just pull those too.

(00:31:39) Nataliya Shcherbatyuk

Yeah, that's pretty, it's a good tip for those who already want to try. Do you anticipate any challenges when we talking about the development and adoption of these hydromulches, and if you do, maybe we can talk a little bit about potential solutions, how we can overcome those challenges.

(00:31:57) Greta Gramig

I think that we can still make many improvements, one challenge is the economics of it as we've already kind of discussed, I think it's going to be probably turn out to be slightly more expensive than using non-biodegradable plastic film mulch, and I talked about the issues with the engineering equipment that is suited for hydromulch mixing and application. So these are the areas I mentioned we struggle the most with during the current project. And I have a lot of ideas about how we could improve some of these aspects, but moving that forward is going to require working with agricultural engineers and maybe some industry partners. So, it would be a different project, I think that there's a lot of work that needs to be done in terms of integrating the application of the mulch with the growing of the crop. So, in our project we applied the mulches and then we planted the crop into them and that's typical of what would be done with plastic mulch, you stretch the plastic mulch to top of the plot and then you place in seedlings, so it's mostly used for plants that are grown or started in the field as either bare-rooted strawberry plants or seedlings, but there's also the idea that you could plant those crops first and then spray the mulch around them, so those are two different ways of

approaching it, and we did have a farmer working on some application equipment and he was trying the idea of using a transplanter and we were using kohlrabi seedlings and so the transplanter would go first and two people would be putting the transplants into the beds, just like you would in a typical operation, and then the hydromulch application would follow behind. And it seemed like that might possibly work too, so we really need to do a lot of different, we need to do a lot of work, working with different crops because they might not all need the same approach, but, and so that's one area, but the other areas have to do with the mixing characteristic, just how thick do you make this mulch and what methods are you using to apply it, maybe there's a different method that would produce a better result, so for instance, right now we are using two passes of hydromulch, so we spray on one pass and then we spray on another one, and the reason for this is that the mulch is sprayed pretty forcefully onto the soil surface, we're trying to make it as gentle as possible, but it's still pretty forceful and that ends up mixing the hydromulch just a little bit with the soil on the top of the raised bed and that soil contains weed seeds, so If you're mixing the weed seeds into the hydromulch then you're not going to get as good of a result because those seeds aren't really going to be covered fully by the full application. So, what we do is one coat kind of seals the soil and then we put another coat on top, but if we could develop an application system that wasn't so forceful, and I have some ideas about what that would look like, and how that would work, then we would be able to just use a single pass which would cut the costs down a lot, and there's other ideas that I have too, that are mostly about fine tuning the physical characteristics of the hydromulch slurry and fine-tuning the application equipment to get the very best result, but I'm a plant scientist and that those sort of questions are really outside my area of expertise. I know what we need to achieve, but I don't necessarily know how to build a machine that's going to achieve that.

(00:36:50) Nataliya Shcherbatyuk

But you are collaborating with some engineers, correct?

(00:36:54) Greta Gramig

No, we aren't, not at this point. That's why our initial idea was just to work with farmers and we kind of wanted, we also envisioned something that would be accessible on a DIY level to farmers and so we kind of started there and I think the large scale commercial application would need to come from future collaborations and partnerships.

(00:37:27) Nataliya Shcherbatyuk

It's interesting that you mentioned farmers because I actually wanted to ask you that based on your experience and collaborations with farmers, how receptive do you think organic horticulture producers will be willing to adopt these new mulches and I'm talking about hydromulches, of course, when they are developed.

(00:37:50) Greta Gramig

Sure, that's really an important question because if farmers don't want to use it then why bother, and as I mentioned, we did have farmers that were involved in the current project and they were interested in it and then when we report our results at field days producers are always really interested in this, and in fact, the current OREI project happened in the first place because of interest shown by a grower. I had the results of the initial pilot project I did about hydromulches published on a website called eOrganic and a producer saw that there and he contacted someone in his state, my current collaborator Lisa DeVetter and asked her - hey could we try this - and so she emailed me about it and I said - well let's write a grant - and that's how the whole project got started, was because a grower was interested.

(00:39:03) Nataliya Shcherbatyuk

Oh, that's so nice to hear, because we do want to work on something that will be useful for growers at the end.

(00:39:10) Greta Gramig

I think a lot of growers, especially in the organic sector, are aware of the problem of plastic pollution and would really like to do more to reduce their use of plastics.

(00:39:24) Nataliya Shcherbatyuk

Yeah, that's great, that's great. Well, Greta, I'd like to thank you so much for joining us today. It was a very interesting conversation and I have a feeling that I'll be reaching out to you maybe in a year when you have more results when we can talk more about what you discovered, what interesting results you received and we can provide that information to our listeners. Thank you so much.

(00:39:49) Greta Gramig

Okay, okay, thank you.

(00:00:00) 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 website www.smallfruits.wsu.edu and choose mulch technologies. This work is supported by the 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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