Mulch matters: exploring the impact of plastic (PE) and biodegradable (BDM) mulches in agriculture.

(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, and let's welcome our project director, Dr. Lisa DeVetter. Hi, Lisa. It's so great to have you here with us today. How are you?

(00:01:15) Lisa DeVetter
I'm good, Nataliya. You're doing well, in addition?

(00:01:19) Nataliya Shcherbatyuk
Oh, yeah, absolutely. So, Lisa, let's start with talking a little bit about yourself. Tell us, what's your role in WSU?

(00:01:30) Lisa DeVetter
Yeah, I'm an associate professor in the Department of Horticulture at Washington State University, and I lead the small fruit horticulture research and extension program. I'm based in northwestern Washington, so I have the opportunity and privilege of working with small fruit producers that include red raspberry and blueberry producers as well as strawberry and blackberry. Over the 10 years that I've been at Washington State University, some of the projects that I've focused on and continue to work on include improving pollination, nutrient management, both in conventional and organic systems, harvest mechanization, so, trying to find opportunities to machine harvest for fresh market, which has some labor-saving and cost benefits, and then mulching, which is what brings us here today.

(00:02:18) Nataliya Shcherbatyuk
Yeah, before getting to mulching, tell me what's your favorite berry.

(00:02:23) Lisa DeVetter
My favorite berry, it really depends on the season. So right now, the blueberries are starting, and I've been harvesting raspberries for trials every other day since June 24th. So, it's almost, it goes to be over a month of intense harvest, which I love, but after a while, red raspberry no longer becomes my favorite fruit during that period. And I start to get eager for blueberries and then blackberries. So, it depends.

(00:02:51) Nataliya Shcherbatyuk
Yum. I love those all. Yeah. Okay. Let's go back to the mulch and let's talk specifically plastic mulch. So, we do talk a lot about plastic mulch in our mulches than just the plastic mulch, but I don't think we actually covered the history of the plastic mulch. So, can you tell us about the history and then benefits of plastic mulch in agriculture and not only for the United States but actually, on the global scale?

(00:03:20) Lisa DeVetter
Yeah, absolutely. So plastic mulch, I'm typically referring to polyethylene, or we commonly just abbreviate it as PE mulch. It's been a really important tool in agriculture production systems since the 1950s and what it does is it helps with improve weed management, reduce soil water loss by limiting evaporation by having that barrier over the soil surface, that barrier and the color, particularly when it's black helps with elevating the soil temperature, which can lead to increases in crop growth and subsequent yield. In addition, that barrier can help improve crop quality and the cleanliness of that crop because it's no longer resting on bare soil. And then it also can optimize or shorten the harvest period as well. So those are some of the benefits of polyethylene or plastic mulch. And I want to credit Emery Emmert, he is the father of *plasticulture*, and he's one of the primary scientists that has been credited with pioneering the use of polyethylene mulch films in specialty crop production systems. A lot of the polyethylene mulch used nowadays is black color. But it's interesting if you go back to some of that earlier research, a lot of the early research focused on comparing clear versus black plastic mulch in specialty crops. Black has a lot of benefits, but it's not the only color. There are other colors that are out there that we might talk about a little bit later. But I want to address your question about global use because it is a really important tool, not just for specialty crop producers in Washington, where I'm at. But it's important for U.S. producers as well as globally, and it's really increased very steadily over time with regards to just expanding its distribution across the globe as well as expanding into new crops. Just a little plug for my program and some of the great student work that's been done. My program has had students that have researched black polyethylene mulch as well as biodegradable alternatives in perennial fruit systems, such as floricane

fruiting red raspberry. We've shown that it's a really valuable tool for establishing delicate tissue culture transplants in the spring. And that can lead to reduced herbicide applications and hand weeding costs, so a lot of benefits associated with it as an establishment tool for young perennial fruit crops and blueberry also uses plastic mulch. Mostly we're referring to kind of the woven polyethylene, sometimes polypropylene plastics that we call weed mat or landscape fabric. And so, just kind of highlighting it's expanding in different crop systems beyond just the strawberries that we typically are referring to or we're focusing on in our specialty crop research initiative grant and vegetable crops and just to kind of put some numbers behind it back in 2021 *MarketsandMarkets* issued a report that estimated the annual growth rate of the global polyethylene mulch film market to be 6.5 percent and reach a market value of 15.7 billion U.S. dollars. Every year when you read those market reports, this is kind of this continued increase and expansion and forecast to expand and that's because of the many benefits that polyethylene mulch provides to producers around the globe.

(00:06:48) Nataliya Shcherbatyuk
I didn't realize that it's that high of a number.

(00:06:51) Lisa DeVetter
Yeah, it might be even higher. That was in 2021, but those are the more recent statistics that I have right now.

(00:06:59) Nataliya Shcherbatyuk
Okay. And I'd like to take you back to the strawberry production and tell us why actually this plastic mulch is so important for strawberry production.

(00:07:12) Lisa DeVetter
Yeah, absolutely. Well, I do want to start out and say that not all strawberry really benefits or requires mulching. I'm from Iowa originally. And so, the type of strawberries that we grew up with were June bearing matted row production system. So, the plants throw out a lot of these above ground stems we call runners, and there's really no use for polyethylene plastic mulch in those systems. But if you buy strawberry in the store, and it's coming from Florida or Mexico or California, which is one of our largest national producers of strawberry, it's going to be grown with polyethylene plastic mulch, and it really benefits from it for a multitude of reasons. So, you know, one, that plastic mulch and strawberry helps optimize that soil microclimate. So that means modifying the temperature to a suitable level. And that really depends on where you're growing. So, some areas where it's hot, they want cooling effects from

that mulch, so they'll go with lighter color mulches. Some areas want warming or some warming, but not too much. So they might go with a black or a green, respectively. Also helps with soil moisture optimization, like we talked about a little bit earlier by providing a barrier to reduce soil water evaporation, and it can also have some impacts on the canopy because some of the mulches that have reflective properties can have impacts on canopy growth, what type of wavelengths of light those crops are being exposed to, and even impact the biology and sensory perception of pest species, like certain arthropods or insects. It also helps with weed suppression, and you have that barrier? So that can eliminate a lot of weeds from growing, and that has some benefits by reducing the need for herbicides, and then it also can benefit fruit development, like what we talked about. So, getting your fruit earlier and helping you reach that target market that you're trying to reach as a producer. And then a lot of strawberry is fumigated. There might be biological fumigant alternatives, like anaerobic soil disinfestation, which I talked about, I can talk about more if that's of interest, but then there's also standard chemical fumigation. And so, you know, that's really important for a lot of producers to manage soil-borne diseases. And when using those types of fumigants, some growers engage in a practice called bed fumigation, where they're just fumigating the raised bed where the strawberry is grown, not the entire field that would be a broadcast application. So, some of those mulches are made and are considered totally or virtually impermeable films, so they help retain the fumigant in the soil and reduce emissions, which has really important benefits and reducing buffer around the field. And then the last benefit that I can think of, in that multitude of lists, is it helps with that fruit resting on a clean surface. So, it's not in contact with soil, it doesn't rot maybe as quickly, and it has this element of enhancing the perception of food safety as well, given it's not on the soil, but it's on a, quote-unquote, clean plastic surface.

(00:10:24) Nataliya Shcherbatyuk
Yeah, I can imagine that though. And, you know, while talking about plastic mulch, I'm also thinking about the concerns that are now increasing over the plastic waste. So can we speak a little bit about the challenges associated with this plastic mulch and plastic waste?

(00:10:46) Lisa DeVetter
Yeah, absolutely. I mean, plastic mulch is such an important tool for agriculture producers. I don't want to demonize them for using it, but there are some challenges associated with plastic mulch, and that brings us to this Mulch Matters podcast. A lot of researchers, myself included, are trying to address some of those challenges. So let me talk a little bit more specifically about those challenges. Number one is removal. Removal of polyethylene plastic mulch often leads to that film breaking and fragmenting, which leads to microplastics that get into the soil. Sometimes those microplastics can move into the broader ecosystem and become pollutants in natural ecosystems, both aquatic and terrestrial, which is something we definitely do not want to happen. Many of the farmers I've met are excellent stewards, so they also

don't want to be contributing to plastic waste in the environment. But, even with the best stewardship and farming practices, it's practically impossible to avoid fragmentation during removal with most polyethylene plastic mulch technologies that are out there. Once you remove that film from the soil and the field, it's contaminated with a lot of soil and organic debris, sometimes called tramp material. This adds weight, and weight is money for those producers who then have to transport it to, say, a landfill or recycling site. And then once it gets to a site, like a recycling site, which we're excited to see increase and hope continues, that site has to remove those contaminants, which can cause many problems in the recycling process, specifically with mechanical recycling, and that adds costs to the recycler. That can really impact the viability or lack thereof of recycling due to that contaminant load. It's also tricky to remove those contaminants if you have mulches that are embossed or gridded and really hold onto soil particles and tramp. Even if you're planning to landfill that plastic mulch, landfills are filling up in places like California, for example. And so, on the horizon, there's, already vocalizations that there's landfills that are no longer going to be accepting polyethylene mulch. They also have high costs or tipping fees associated with them, and those vary by state and time, but those costs are anticipated to keep going up so, landfills aren't the easy solution as well for polyethylene plastic mulch. So, those are some of the challenges, and, you know, there's a few others. There are some states that allow open burning of plastic mulch, which is also a concern from an environmental perspective as well as a human health perspective and then some producers engage in on site, burial of plastic mulch, so kind of landfilling on their own farm site. And so, we're really focused as a research community that is focusing on improving end of life management practices to help provide viable tools for having more sustainable options for plastic mulch management.

(00:14:12) Nataliya Shcherbatyuk

And speaking of alternatives for sustainable plastic management, we've mentioned several times in our podcast that BDMs, or biodegradable mulches, are seen as a good alternative to plastic mulches. Can you expand on why they can be a good alternative to PE?

(00:14:33) Lisa DeVetter

Yeah, absolutely. Absolutely. So, I'll take a step back, to in my eyes, as a researcher who works with producers, my goal is to provide more tools for that toolbox for growers. So definitely I'm interested in recycling and improving recycling outcomes for polyethylene plastic mulch film, but I'm also equally interested in soil biodegradable plastic mulches. So, these are designed to provide the same horticultural benefits. As polyethylene mulch with regards to, optimizing yield, improving that microclimate, helping with crop quality and crop development. One of the key differences though, is that it doesn't have to be physically removed and disposed. They're designed to be tilled into the soil, whereby microorganisms that are naturally present in those soils will, will break it down and utilize it in their metabolism to you know, function and to grow. Within their own populations, so that has a couple of benefits from the producer side of things. Not only is it reducing the plastic waste generation, but it can help save costs with removal and

disposal, because all you're doing in that situation is telling it in. So, those are some of the benefits that we see associated with biodegradable plastic mulches relative to polyethylene mulch, which is non-biodegradable.

(00:16:01) Nataliya Shcherbatyuk
And while using these BDMs, are there any challenges? And I'm asking specifically for the organic agriculture.

(00:16:10) Lisa DeVetter
Yeah, absolutely. We talk a lot about BDMs or soil biodegradable mulches and organic because I think a lot of those producers philosophically are interested in reducing plastic waste generation and so are interested in soil biodegradable plastic mulches. But when it comes to the requirements or regulations and organic production systems of the United States. So, about a grade of plastic mulches have this kind of “catch 22” situation. They're allowed, but no commercially available. So, about a gradable plastic mulch meets the requirements. The requirements for US organic production and the same applies to Canada as well. We have a lot of neighbors in Canada. So, we think about them very often and part of that is because of the requirements, the big one is the bio-based content requirement. So, right now, the national organic program requires a soil biodegradable plastic mulch to be fully or 100% biobased and there's no commercially available material that is fully or 100 % biobased and there's some discussion about changing that to 80 % biobased content. But there's also no materials that are 80 % biobased content. But from the manufacturers that I've spoken with, they feel like that's more achievable than 100 % biobased content. And then there's a few other, um, conditions or requirements that must be met, such as the feedstocks must be made without excluded methods like GM, that are, you know, somewhat challenges and bears as well. But the biggest challenge right now is that bio-based content, and our team and fellow colleagues have been working with just communicating with the national organic program. Not necessarily trying to persuade, but just trying to provide scientific information about, you know, what these mulches are made of and, how it's, it's really difficult to impossible to have something a 100% bio-based because in addition to feedstocks, there's other additives and compounds that go into making a biodegradable plastic mulch.

(00:18:16) Nataliya Shcherbatyuk
Right, right. And, and you know, you mentioned several times the term biodegradable today, and there are different terms for the degradation. There is biodegradable that we know, but there is also od degradation and for degradation and I think they can be quite confusing. So, can you explain these different, different types of degradation?

(00:18:42) Lisa DeVetter
Sure, absolutely. So, biodegradation, you kind of think bio- biology, it's degradation that's being driven by living organisms. And in the case of soil biodegradable plastic mulches, it's those living organisms, such as the soil microorganisms, the bacteria, perhaps a little bit of fungi that are breaking down the polymers in a biodegradable plastic mulch and using it to basically fuel their metabolism and their physiology and growth and development. So, they're taking the carbon from those polymers and basically eating it and using it just similar to how you and I eat food and use that to function our bodies. And then that carbon, it goes into their, their biomass or their bodies and some of it also is used and expelled as carbon dioxide through respiration that they engage in. Then there's OXO and photodegradable. So, these are not made with biodegradable feedstocks, but they are elaborate a little bit further. Um, they are oftentimes sold as biodegradable and that's erroneous, so you want to make sure if you're. Looking at biodegradable mulch options, you avoid oxo and because they might be labeled as biodegradable, but they are not what they are is they are made with standard conventional plastics, like polyethylene, both. Low and high density, polyethylene polypropylene and a few others, and they have additives added to them that cause them to become brittle and break apart into non-biodegradable fragments for the oxo's is when they're exposed to oxygen and there's this oxidation process and then for the photo photo-degradable, it's when they're exposed to UV light that's what's caused them to become brittle and start to fragment growers are interested in biodegradable mulch options and they need to be wary. And my recommendation is that they really look carefully at standards, such as EN17033 or okay biodegradable soil, which is a certificate program to ensure that the mulch that they're considering is made with biodegradable feedstocks.

(00:20:55) Nataliya Shcherbatyuk
So basically, you're suggesting to also double check the in “ingredients” of the mulch.

(00:21:01) Lisa DeVetter
Yeah, absolutely.

(00:21:04) Nataliya Shcherbatyuk
Cool. Yeah, thanks. Yeah, that's great. Thank you for clarification. And while talking about mulches, we often mention that mulches have beneficial effect on yield and weed suppression. Now, um, can we discuss a little bit about impact of BDMs on yield and weed suppression?

(00:21:22) Lisa DeVetter
Yeah, absolutely. Yeah, absolutely. So, that's a key question or consideration for any producer. They want to make sure that they're having efficient production systems. And that means typically maximizing on yield when it comes to mediums and how they compare to standard polyethylene mulch with regards to impacts on yield, black biodegradable plastic mulches overall based on, I would say, robust meta-

analyses have equivalent effects on yield now, that's not saying there might be 1 or 2 studies] that show a reduction in yield with BDM, but if we look at all the literature published on biodegradable plastics, and we look at how it compares. How you'll compares about available plastics relative to polyethylene mulch, it's the same. Weed suppression in contrast is different. So weed suppression is lower for biodegradable plastic mulches compared to polyethylene. And I think that's going to be really interesting to untangle that a little bit more. We've seen in our own research that we see weeds increase over time as biodegradable mulches near the end of their lifespan in a field, they start to deteriorate, which is part of the goal of these materials will deteriorate before they degrade. And we see weeds, but those weeds aren't necessarily having any effect on the crop with regards to yield. So, it's, you know, we certainly want to control weeds and not contribute to the weed seed bank, but it seems that biodegradable plastic mulches in the cases that I've seen and read the literature, they generally provide enough weed suppression that they're not compromising or limiting yield.

(00:23:09) Nataliya Shcherbatyuk
Great. So basically, what you're saying, then we have these BDMs and we're looking at the weed suppression while the BDMs at the beginning of the growing season, they're doing great job for weed suppression, and later when they are ready to do to creating plants itself already formed and grown enough not to be affected by those weeds.

(00:23:30) Lisa DeVetter
Yep, that's what we're generally seeing. And again, I kind of go back to these meta-analyses that have been done, which is an evaluation and comparison of all published studies that in the literature, and they're showing that yield is really not affected compared to polyethylene, whereas there's a slight reduction in wheat suppression.

(00:23:50) Nataliya Shcherbatyuk
Let's talk a little bit more about research. So, you've done a lot of work with different type of knowledge and not only at WSU where you are based but also with your collaboration work with different states. So, let's talk a bit more about this. Can you tell us what type of mulch did you study? Also, what did you measure? And what was What were the results that you found?

(00:24:19) Lisa DeVetter
Yeah, absolutely. So, we've been really fortunate to collaborate, say, 1st with California, starting back in 2020 with biodegradable plastic mulches. We've been looking at black and green biodegradable plastic mulches and are continuing to do that work in other states in collaboration, such as Florida Nebraska, and then in Washington, of course, where I'm located. And what we've seen so far is that again, we see a slight reduction in weed suppression with the biodegradable plastics, but yield seems to be just as good,

particularly with the black plastic mulch compared to polyethylene mulch. We tend to really focus on yield and crop quality and quality also doesn't seem to be impacted. And then we have a fantastic team of soil scientists and polymer scientists that are contributing knowledge and studying about soil health impacts as well as the fate and residence time of the biodegradable plastics in soil, which is a key part of some of the questions that we get about biodegradable plastics that research needs to address. In addition to the biodegradable plastics, we're also looking at reflective mulches. Those aren't biodegradable as well as new mulch technologies, such as Solar Shrink, which is a polyethylene mulch film. It's engineered and designed to be much thinner than traditional polyethylene mulch, stronger, so it rips and tears less during removal, and then have less contaminant load and I think that's an exciting technology, particularly in states and systems that have the infrastructure to recycle. So, we're studying that and trying to understand how well that can possibly work in strawberry production systems.

(00:26:09) Nataliya Shcherbatyuk
Interesting, and now let's look a little bit on the practical side of BDMs. So, is it difficult to apply BDMs in agricultural settings?

(00:26:19) Lisa DeVetter
That's a great question. We get that one a lot from producers and no, it's really not any more difficult when you're starting to apply it you can use the same equipment that you use traditional polyethylene mulch to lay and apply that mulch film. Anytime you switch to a new mulch roll, you'll want to adjust the machine settings. And so there takes a little bit of time, maybe a few minutes to figure out the nuances of that particular roll but once you figure out those nuances, you're applying at the same speed. And rate that you would with traditional polyethylene mulch film. I wanted to kind of jump back to the last question too, because I remember that we are also doing collaborative research on bio based mulches that are sprayable and so that's hydromulch, I think we've talked about it in the past on our podcast, and those potentially are going to be even easier to apply since it's something that can be sprayed on potentially once in a season with follow up spot treatments as needed. But that's something that is an emerging technology that's not yet broadly commercially available, but it's exciting since it would be bio based and could meet the requirements as a biodegradable mulch and organic production systems.

(00:27:36) Nataliya Shcherbatyuk
Looking a little bit ahead of time, where do you see the use of BDMs in the next, let's say, five years?

(00:27:43) Lisa DeVetter
Yeah, that's a, that's an interesting question. It's hard to say. I guess I hope to see, you know, the science demonstrates that it's a good tool or a good alternative for producers. So, I hope to see its expansion of the mulch use, but really, it kind of rest on producers really know what's going to be best for their

operation. So, there's a little bit of. Give and take, I would say, or dialogue that will have to occur over these next 5 years to see where it ends up going. I think from where I stand right now, battery plastic mulches are a great alternative, but it might not work for every production system. So, learning those nuances and where it works and maybe where recycling is a better option and having a more robust understanding and be able to communicate kind of a very clear decision strategy to producers is something I would like to see in the next few years.

(00:28:45) Nataliya Shcherbatyuk
Yeah, now that you're saying that, I'm thinking, like, for example, in organic agriculture, it seems like BDMs having a hard time to be commercialized, at least at this moment, and if recycling option can be improved, that might be having a little bit better future path than BDMs, but we shall, we shall see.

(00:29:06) Lisa DeVetter
Exactly. And, I always think again, the more tools that we have and information about, um, the benefits. And the challenges associated with each tool, so the better so that producer's consultants can make informed decisions that are best for their unique settings.

(00:29:24) Nataliya Shcherbatyuk
Right. As well, it's also good to have several options if any producer wants to choose what they want to go with. And do you have any exciting or interesting information about mulch and mulch overall that you want to pass on to our audience?

(00:29:44) Lisa DeVetter
You know, I, as I started off, I mentioned, I also do a lot of research with pollinators and it's been really interesting to see some literature come out of the University of Wisconsin, Madison and other places to show that mulches can have an impact on arthropods we're primarily focused on pest species like spotted winged drosophila in raspberries and there's some really interesting research that's been published and maybe we can link to it, um, somehow in the podcast that shows that it can impact certain pest species, but it might also impact pollinators. A really interesting field, because even though strawberry is not highly dependent on insect mediated pollination, thinking about other cropping systems and how adjusting will just impact these interactions between pests and beneficials like pollinators is really interesting. So, I don't have any concrete information, but it's, it's research that's building that I'm excited to see continue to build and maybe contribute to as well.

(00:30:50) Nataliya Shcherbatyuk
That's great. And that means that we're going to have you back on the podcast at some point soon to talk more about pollinators and mulch.

(00:30:57) Lisa DeVetter
That would be awesome.

(00:30:59) Nataliya Shcherbatyuk
Well, Lisa, thank you so much, there is so much new information and I hope our audience really excited to hear more about future that we have for the research and mulches.

(00:31:10) Lisa DeVetter
Sounds good. Thanks for having me. And thanks for your patience too, while we scheduled this during our, our busy berry season.

(00:31:18) Nataliya Shcherbatyuk
Of course, yes, by the way, it's being recorded like probably one of the most busiest part of the year right now.

(00:31:24) Lisa DeVetter
That's okay. We made it work.

(00:31:28) Nataliya Shcherbatyuk
Correct. Yes. Thank you so much, Lisa. 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 www.smallfruits.wsu.edu 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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