

Maximizing crop performance with biobased mulch: insights from Sam Wortman

(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

In our previous episodes, we spoke about the benefits of mulch, how it helps to reduce weeds, conserve water, and many other things. We also spoke about our project which is improved end-of-life of plastic mulches in strawberry systems, its goals and objectives. But with today's guest, we will talk not only about mulch in strawberry production but also about how to use it and what kind of mulch we can use while growing plants like lettuce, spinach, carrots, onions, sweet corn, beans, even cut flowers. Isn't that exciting? And without any further due let's welcome Sam Wortman, who is an associate professor in the Department of Agronomy and Horticulture at the University of Nebraska, Lincoln. Sam, thank you so much for joining us today.

(00:02:04) Sam Wortman

My pleasure, happy to be here.

(00:02:07) Nataliya Shcherbatyuk

Can you tell us a little bit about yourself and your horticultural background?

(00:02:12) Sam Wortman

Yeah, sure. So, I guess my journey in horticulture started probably around 2007 when I was starting graduate school. I did a master's and PhD in Agronomy at the University of Nebraska and I studied organic systems. So, I was studying organic crop rotations looking at soil fertility and weed management, but then got interested in cover crops, and so, I was growing a lot of *Brassicas* and legumes, and doing diverse

mixtures of cover crops and how we can fit those into diversified organic crop rotations. So, when I finished my PhD, I got really interested in urban agriculture and that's really when I went kind of headfirst into growing food crops and horticulture. I did that work at the University of Illinois, so I was an assistant professor in the crop sciences department there for 4 years working on urban food production. So, we were looking at some questions in the Chicago metro region about, for example, how vegetable crops respond to the urban environment. So urban heat island effects, higher CO² concentrations, pockets of potential ozone pollution, light pollution, and light interference. So, we grew a number of different vegetable crops and varieties and tried to explain some of the variation that we were seeing in how vegetables grow in that urban environment and concurrently we were starting to do a lot of research on biodegradable and biobased mulches.

So, my first introduction to that was a collaboration with Ignatius Kadoma, who's a material engineer at 3M and they were trying to explore some different prototypes of biobased mulches that were primarily made from the polymer, PLA (polylactic acid). And if you look into the literature, about the same time, kind of that 2010 to 2015 timeframe, there were a number of us around the US, including many members of this SCRI project looking at biodegradable mulches and strawberries who were all testing similar prototype PLA mulch. At the same time, they were a spun-bond product that had a much heavier weight basis than a typical biodegradable plastic film. It has kind of the consistency of a row cover like a relay row cover for frost protection or insect barrier. But it was again biobased compostable and so they were looking at that as a replacement for plastic and after about 3 years of research on that we kind of came away from that with the conclusion that it wasn't a great substitute for biodegradable plastics or even plastic mulch film, because it was just a very different product, right? It was heavier and it's not a film, so it doesn't have the same thermal properties.

So, it does not warm the soil in the same way and so we started to kind of explore there. This is a useful thing, right, it's helping us to control weeds, and it in some cases conserves moisture, so there may be a different application of how to use this otherwise useful material than just thinking about it as a replacement for plastic in tomatoes, peppers, cucumbers, or strawberries. And so that's where we started doing some initial research after I had gotten to the University of Nebraska, and we started doing some work to ask the question: could we grow crop roots through this particular fabric, because it has kind of a permeable property to it and the question was is it permeable enough for a root to grow through it, but not permeable enough for a weed shoot to grow up from beneath it. And so, we started out in basically Petri dishes in the lab and then we bumped it up into greenhouse pots, and for the last few years we've been doing field studies in carrots, strawberries, lettuce, kale, and some other crops to kind of prove out this concept and to really build out the agronomics of this really unique production system where we plant our seeds directly on this PLA-based fabric along with a thin layer of compost just to germinate and establish the seeds, but they grow through the fabric and then at the end of the season when we're done using it we can remove that PLA fabric from the field and it can be composted. And we like it, because then we can

take that compost that it produces and we can use it, you know, down the road as that substrate that we germinate our seeds in.

(00:07:02) Nataliya Shcherbatyuk

That's fascinating, and just to clarify: so you haven't used plastic for this type of production because of the holes you would need to make in the plastic and then the problem would be probably to pull it down at the end of the season?

(00:07:19) Sam Wortman

Yeah, good question. Yeah, so that's exactly right. What we're trying, the problem we are trying to solve with this PLA-based fabric is finding weed suppression options for crops that are grown at higher densities and higher populations. Where historically plastic or biodegradable plastic films have not been an option because you would plant at such a high population that the number of holes that you would have to make in the film would render it useless, right? It would completely be shredding it. And that's why plastic films or bioplastic films work well for tomatoes, peppers, melons; and things that are spaced out at least 12 or 18 inches apart but if you're going to plant beans or sweet corn, and you want to have a seed every 2 to 6 inches, then that's a lot of holes, right? And every hole that you make is an opportunity for a weed to grow through it; and so the idea was that we don't want to have any holes, we just want to find crops and create a fabric that allows us for those crops to actually grow through it, but still keeping the weeds down below it and I'll say the toughest one is grasses and sedges, and that's true for any plastics as well that they have an easier time growing through barriers because of their emergence pattern. But so that's been where some of the research comes in is finding the right material and so that's kind of led in, you know, where my journey ends today at least is. About six months ago we started a company called "Sage Eco-Innovations" to try to commercialize this concept and so we developed a new formulation that's patent pending right now and we're hoping to bring that to market so that we can start to control weeds with mulches and bio-based compostable mulches in those crops on small farms.

(00:09:20) Nataliya Shcherbatyuk

This is fantastic and super interesting. It would be really interesting to actually see the application and how it's being done. Yeah, so can you tell us what brought you to this project?

(00:09:33) Sam Wortman

Yeah, so what brought me to this SCRI project on strawberries is that we have quite a few small-scale local growers in Nebraska and really throughout the Midwest who are becoming very interested in

strawberries. I think a quote from one of the growers that I work closely with is: "If he can find a way to reliably produce strawberries from year to year, it's like printing money at the farmer's market" because he sells out of strawberries before he sells out of anything else. The demand is far greater than supply right now at local markets and so others are taking notice of that and so we've seen a lot of people planting strawberries and there in Nebraska, there's a lot of different ways that you can grow strawberries. And people are trying all different things, so you can grow them in greenhouses and hydroponic systems, gutter systems, and then in terms of field production you can grow them annually, you know, in a way like you might in California where you plant them in the fall and harvest a June-bearing berry the following spring, but a lot of growers here also do the perennial matted row system where they're going to plant it in the spring allow it to grow and prune off flowers for the first year and then harvest in years 2-3 and 4 from a perennial from those mother plants and also the daughter plants that have established. It's a little bit of a lower intensive system, slightly lower yields, that system doesn't require plastic, but as are in Nebraska we're kind of in this transitional zone where our winters have been getting milder and so we're kind of on the border of where you can reliably over winter strawberry and a plastic culture system and so we have growers that are interested in starting to plant fall strawberries for a spring harvest just like the system that we see in commercial systems and in the West Coast. And then we also have a number of growers who are still planting bare root plants in May and planting maybe day-neutral or ever-bearing varieties so that they can get a couple of harvests of it in just 1 year, so I've seen all of those systems on a variety of different farms across Nebraska. And so, what we're looking at is that kind of spring-planted ever-bearing varieties and how could biodegradable plastics be fit for that particular system.

(00:12:14) Nataliya Shcherbatyuk

Interesting, super interesting and we touched a little bit about the difference between biobased and plastic molecules, but could you explain more about what biobased and biodegradable mulch is and how it actually differs from plastic mulches, the traditional plastic mulches?

(00:12:32) Sam Wortman

Yeah, so a biobased mulch implies that it is made from 100 % biobased content and that can be very different from biodegradable. So, biobased content which there are kind of biobased certification programs that the USDA [created] you're just tracing the source ingredients or polymers to something that is biological, right? So, it's usually cellulose, lignin, polylactic acid, or something like that. But in many cases, those biobased polymers are also very durable and not necessarily biodegradable in soil and so that's where you get a difference between biobased and biodegradable is that biodegradable means that there are international standards for that and essentially kind of a common way to measure that is that 90% of the material needs to be respired as CO² by microbes in soil or some substrate within a certain amount of time. Usually, for most of our soil standards, it might be 12 or 24 months and so there are different

certification programs to achieve certified biodegradable in soil-based on the ability of microbes to use it as a carbon source and respire it off as CO². Now, it doesn't mean that there's not going to be some trace amounts of plasticizers or something else left behind in soil but the majority of it is getting biodegraded and that's where a lot of our research comes in. Even if something's certified biodegradable in soil and maybe we don't visibly see it there, are there chemicals, polymers, or organic compounds that are left in the soil, and if so, how long do they stay there, does that influence soil health? Those are the types of questions that we're going to be exploring in this project, but you know the main thing is just that biobased and biodegradable are not interchangeable because most of the biodegradable mulch films that are commercially available, they'll have so typically some biobased content, maybe between 20% and 40%, but the rest of those are polymers that are biodegradable but are not biobased.

(00:15:04) Nataliya Shcherbatyuk

Yeah, and I think this is very important to emphasize because there is a confusion that I've met that some people think if it's for example, 20% biobased they think it's 20% biodegradable as well. Which is absolutely not the case. So yeah, it's important to deliver to our audience as well. And are there any benefits of biodegradable mulch for soil health and fertility?

(00:15:32) Sam Wortman

Yeah, good question, I think the jury is still out on that, we're still studying it, you know, I've seen some research that suggests basically no effect on soil health, which I think from the perspective of encouraging the adoption of biodegradable mulch films that's a positive thing is that we're at least you know, doing no harm to soil health. And I've seen some other studies depending on the polymer, where there might be some shifts in microbial community composition. So, some of our research using polylactic acid-based polymers, they contends to increase fungal populations in soil because it's a fairly recalcitrant carbon source that the fungi can use as a food source and also habitat; and so, we've seen that now whether or not that results in any practical changes in soil health we haven't measured that in terms of fertility. I don't think that there's much difference. We asked this question, we looked at whether or not residues in the soil. So, if I were to till in a biobased or biodegradable mulch into soil and then I plant a crop the next season, we asked the question, you know, is that in any way influencing nutrient availability and subsequent yield of the crop, and we didn't really see any effects of that in most cases and so I don't think that there's any, at least short-term, effects on soil productivity or soil fertility.

(00:17:23) Nataliya Shcherbatyuk

Interesting, very interesting. If you talk to farmers, so basically anybody who would like to transition from traditional plastic mulch films to compostable alternatives, what would be the main consideration you would suggest thinking about?

(00:17:45) Sam Wortman

I think that 2 important things to keep in mind when considering a switch from traditional plastics to certainly biodegradable films is that you know the most obvious thing is that there is a cost difference. And so you really need to when you're assessing the cost-benefit ratio you do need to consider time and labor, and fuel use, and all that in terms of what it's going to take to remove plastic from the field. And also you know how much plastic might get left behind from a soil pollution aspect. And then also include you know mulch disposal fees, so, landfill tipping fees, burn permits, whatever it might be, depending on where you are, and then you know the possibility that you're going to be removing soil nutrients, some organic matter from your field depending on how much contamination is on that plastic film, so in almost every case that I've seen you know the biodegradable plastic films are going to be more expensive and but you really need to do that full lifecycle analysis before you can assess whether or not it's going to be cost-effective. And then the second thing is just in the I guess expectations about performance, because the biodegradable plastic films that I've used so far, now we're testing new formulations all the time, but the ones that I've used are more susceptible to some small rips and tears as you get further into the season. A good case can be made that once you reach a critical period of weed control where you're unlikely to see any yield loss from a weed that germinates and starts to grow two months after you transplant, you know, the field might not look as clean as you were hoping, but that weed that comes up and starts to grow is not going to affect your yield, you may want to remove it so that it doesn't produce seeds for next year, but generally, those biodegradable films are getting you enough weed suppression and moisture conservation for the time when the crop really needs it, and then towards the end of the season it's more of an aesthetic issue that the plastic films that are maybe more durable are going to keep that field looking clean for a longer period of time, whereas the biodegradables may start to deteriorate and it doesn't look as nice. But functionally the benefits you know you've already realized the agronomic or horticultural benefits of it, so there is a mindset shift in terms of just the aesthetics and the performance expectations.

(00:20:41) Nataliya Shcherbatyuk

Those are great points and I would also think that it's important to consider the long-term overall benefits. Not only the one season but how it's going to influence several years ahead of time. Like you mentioned, we don't know what nutrients will be removed with the plastic mulches and if you're doing it every year then that needs to be considered as well. Yeah, and I would like to ask you a fun question, which I think is fun for me. You worked with a lot of crops and when I saw that you worked with, you know, lettuce

and beans, but flowers? That's really interesting, but is there a crop that you find interesting to work with, but you don't have any experience yet?

(00:21:29) Sam Wortman

Yeah, that's a great question. A crop that I have not worked with really at all but I really enjoy eating and I think it would be fun to grow is asparagus. You know, just because it's a rare perennial vegetable, and for me part of the reason I'm interested in someday working with it is that, you know, it poses some interesting weed management questions. Especially from a nonchemical standpoint, which is mostly what I work with, you know, and even around questions about mulch, you know. Is there some type of creative mulch solution for a crop like asparagus? One does not come to mind, but never say never so that's kind of what intrigues me about asparagus is the perennial nature, very unique growth habit, you know, canopy architecture, all that fun stuff.

(00:22:27) Nataliya Shcherbatyuk

Yeah, that's interesting. I never thought about actually growing asparagus in mulch, which is, yeah, now I'm thinking about that too.

(00:22:33) Sam Wortman

You know, I have seen it grown in mulch, but it was a video I showed my students, where they're growing white asparagus. So that's a system where they create a giant raised bed and then they cover it with light impermeable film so that, you know, excludes all light and they get that white pigmentation on the asparagus spears.

(00:22:55) Nataliya Shcherbatyuk

Nice. Where was that?

(00:22:58) Sam Wortman

Yeah, I don't know where it was but just mostly to highlight, you know, the influence of the environment on produce quality.

(00:23:08) Nataliya Shcherbatyuk

That's pretty cool. Yeah plans, they are just fantastic. Well, Sam, thank you again so very much for the great discussion and a note for our listeners: if you want to learn more about Sam's passion, feel free

to check out his website. It's the RootThru Weed Barrier website that you can find at www.rootthrugarden.com. Is that correct what I said?

(00:23:35) Sam Wortman

That sounds great, yep, and that's where you can learn about this new commercialization effort for the RootThru Weed Barrier, if you're interested in learning more about my research at the University that's where you can go to agronomy.unl.edu/wortman and you'll find my research projects at UNL there.

(00:23:57) Nataliya Shcherbatyuk

Thank you so much. Sam.

(00:24:01) Sam Wortman

Yup, thank you for having me.

(00:24:03) 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](https://www.instagram.com/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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