Soil-Biodegradable Mulches: *Workshop*

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Presenter Notes **July 2020**

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Synopsis:
Soil-biodegradable mulches (BDMs) have provided comparable horticultural benefits with polyethylene (PE) mulches in terms of weed control and crop yield.

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This material is based upon work that is supported by the National Institute of Food and Agriculture, under award number 2016-51181-25404. Any opinions, findings, conclusions, or recommendations expressed in this publication are those of the author(s) and do not necessarily reflect the view of the U.S. Department of Agriculture.

USDA United States Department of Agriculture National Institute of Food and Agriculture

Weed Control

This workshop series provides slide presentations on soil-biodegradable mulches (BDMs). These notes provide additional information for presenters. Numbers in the text correspond to the slides in each presentation. Information in this document was summarized from publications listed in the Reference section.

1. This presentation provides information on the use of soil-biodegradable mulch (BDM) for weed control, effect of different colors of plastic mulch on light and weed control, how percent soil exposure (PSE) relates to weed growth, and comparison between polyethylene (PE) mulch and BDM in terms of weed control and crop yield.
2. Weed control is the primary function of mulch. Weeds compete with the main crop for nutrients, water, and

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light which causes adverse effects on crop growth. PE mulch is very effective for weed control, but what about BDMs?

3. This table (Table 1) shows the comparison of the effect of different colors of plastic on light and weed control. For example, black plastic mulch has low light reflectivity, high light absorptivity and low light transmission, thus it provides excellent weed suppression. Clear plastic mulch provides poor weed suppression because of high light transmission. Mulches that selectively filter out light in the photosynthetically active radiation (PAR) range are called infrared transmitting (IRT) mulches. IRT mulches tend to transmit high percentages of light at longer wavelengths (>900 nm) and allow for greater soil warming while reducing light available for weed growth.
4. The graphs (Fig. 1) show the percent soil exposure (PSE) during the pumpkin growing season of about 16 weeks in Mount Vernon, WA in 2018 and 2019. When the mulch deteriorates, the soil gets exposed and there is potential for weed growth. 0% PSE denotes completely intact mulch while 100% PSE denotes completely deteriorated mulch. Ratings were in 1% increments up to 20% PSE, and in 5% increments thereafter. PSE was highest for Clear Organix mulch in both years (63% in 2018, and 74% in 2019). All other BDMs reached a maximum of 10% PSE in 2018 and 15% in 2019.
5. This table (Table 2) shows the weed populations per m² under mulch at three different times, early season, mid-season, and late season in 2018 and 2019. Weed number was low for all the treatments except Clear Organix mulch (COX) in 2018 and 2019 plus Clear polyethylene mulch (CPE) in 2019. Weed growth occurred beneath the clear plastic mulch treatments because they allowed light transmission. However, weeds continued to grow in Clear Organix mulch (COX) due to splitting early in the season. The higher weed number in Clear polyethylene mulch (CPE) in 2019 was likely due to higher soil moisture than in 2018. Weed growth in late season was due to mulch deterioration. Other BDM treatments provided effective weed control similar to black polyethylene mulch.
6. This (Fig. 2) is how Black Organix mulch (BOX) and Black polyethylene mulch (BPE) look in July 2019 and October 2019 in pumpkin. They are both intact with essentially no weeds.
7. This graph (Fig. 3) represents the PSE for a period of 1 year during raspberry production in Lynden, WA. At 16 weeks, BDM deterioration was about 8% on average, similar as with pumpkin. But 1 year after application,

Table 1. Comparison of the effect of different colors of plastic on soil temperature, light and weed control.

Plastic Color	Soil Temp. (2-4'' depth)	Light Reflectivity	Light Absorptivity	Light Transmission	Weed Suppression	Comments
Black	Increases (3 to 5 °F)	Low	High	Low	Excellent	Most common. Does well in temperate climates.
Clear	Increases (6 to 14 °F)	Low	Low	Very High	Poor	Best in cool regions and for fall crops.
White/ silver	Decreases (-2 to 0.7 °F)	High	Low	Low	Excellent	Reflection interferes with movement of aphids. Best for tropical climates.
Infrared Transmitting (IRT)	Increases (5 to 8 °F)	Low	High	High	Excellent	Selective light transmission. Transmits the sun's warming wavelengths (like clear), but not those that allow weeds to grow (like black).

Angima, 2009; Penn State Extension, 2015; Sanders, 2001 all the black plastic BDMs reached about 90% PSE while PE mulch remained almost completely intact.

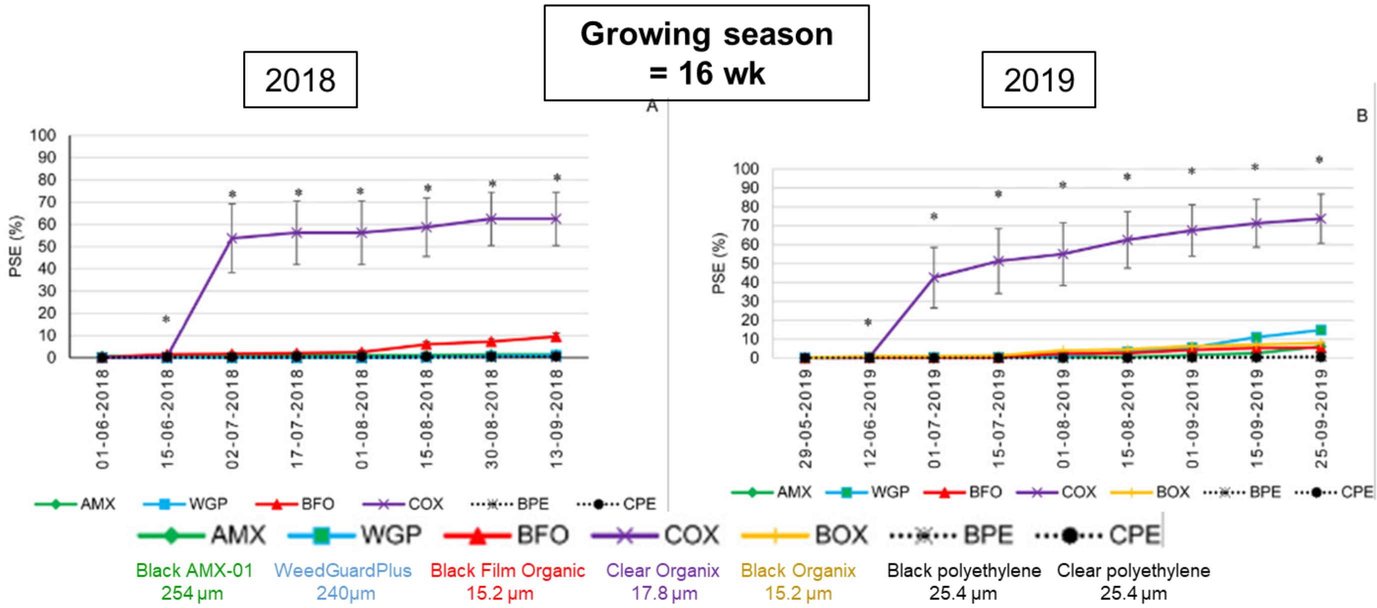

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Figure 1. PSE during pumpkin growing season in Mount Vernon, WA; 0% = completely intact, 100% = fully deteriorated, ratings in 1% increments up to 20%, and 5% increments thereafter; error bar is ± one standard error of the mean. 25.4 µm = 1 mil.

Table 2. Weed populations per m² under mulch in pumpkin.

	Weed number per m²					
	2018			2019		
Treatment	Early season (3 WAT[z])	Mid-season (10 WAT)	Late season (15 WAT)	Early season (3 WAT)	Mid season (10 WAT)	Late season (16 WAT)
AMX	0 b[y]	0 b	0.5 b	2.3 ab	0 b	0.3 bc
WGP	0 b	0 b	0 b	2.0 ab	0 b	4.0 b
BFO	0 b	0 b	0.8 b	1.3 ab	0 b	0 c
COX	2.0 a	10.0 b	21.0 a	6.8 a	77.5 a	89.5 a
BOX	—[x]	—	—	7.0 a	0 b	0.3 bc
BPE	0 b	0 b	0 b	0.3 b	0 b	0 c
CPE	2.5 a	0 b	0.5 b	2.3 a	16.5 ab	39.0 a
P value	0.04	0.03	0.03	0.02	0.02	0.02

[z]Weeds were collected 3 weeks after transplanting (WAT; 22 June 2018 and 20 June 2019), 10 WAT (9 Aug. 2018 and 8 Aug. 2019), 15 WAT (14 Sept.) in 2018, and 16 WAT (26 Sept.) in 2019.
[y]Means followed by the same letter in the same column are not significantly different at $P < 0.05$, using a nonparametric multiple comparisons Wilcoxon test.
[x]This treatment was not included in 2018.

Weed number per m² in plots with 'Cinnamon Girl' pie pumpkin grown with clear and black polyethylene (CPE and BPE) and soil-biodegradable mulch treatments [AMX-01 (AMX), WeedGuardPlus (WGP), Black Film Organic (BFO), Clear Organix (COX), and Black Organix (BOX)] in 2018 and 2019.

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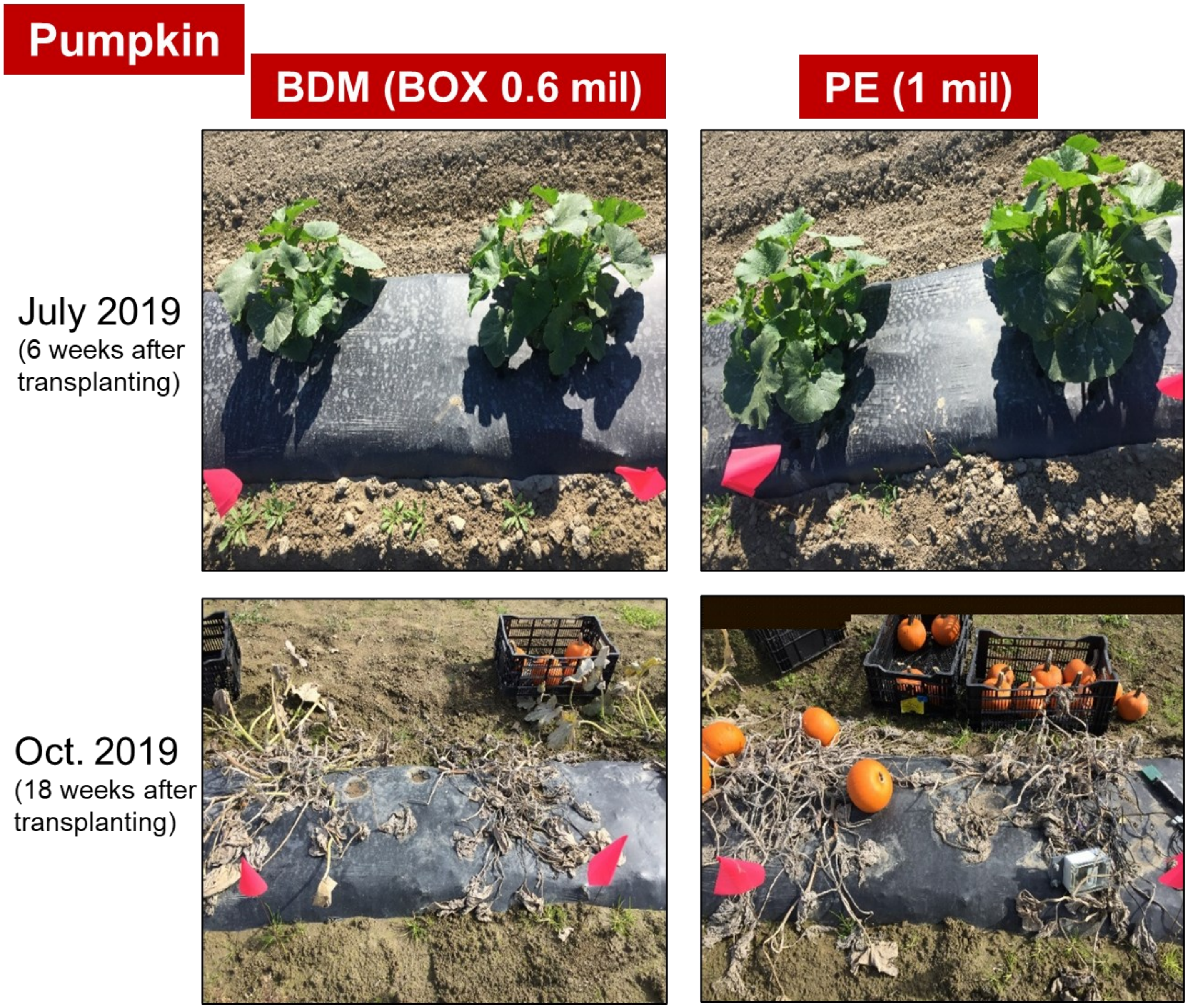

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Figure 2. Comparison of BDM (BOX) and PE mulch during pumpkin production.

8. This (Fig. 4) is how BDM and PE mulch look in June 2017 and December 2017 in raspberry. BDM is deteriorated and has weed growth while PE mulch is intact with no weeds.

9. This table (Table 3) represents crop production with BDMs. In the same pumpkin study, fruit yield and weed control were comparable between black plastic BDMs and PE mulch. Yield is greater compared with bare ground and essentially the same as with PE mulch in other crops. Weed control varies between BDM and PE mulch depending on crop and location. BDMs tend to deteriorate after 12 weeks and while this leads to some weed growth, it tends to be late enough that it has little impact on yield. Thus overall, BDM has shown comparable horticultural benefits with PE mulch in research results.

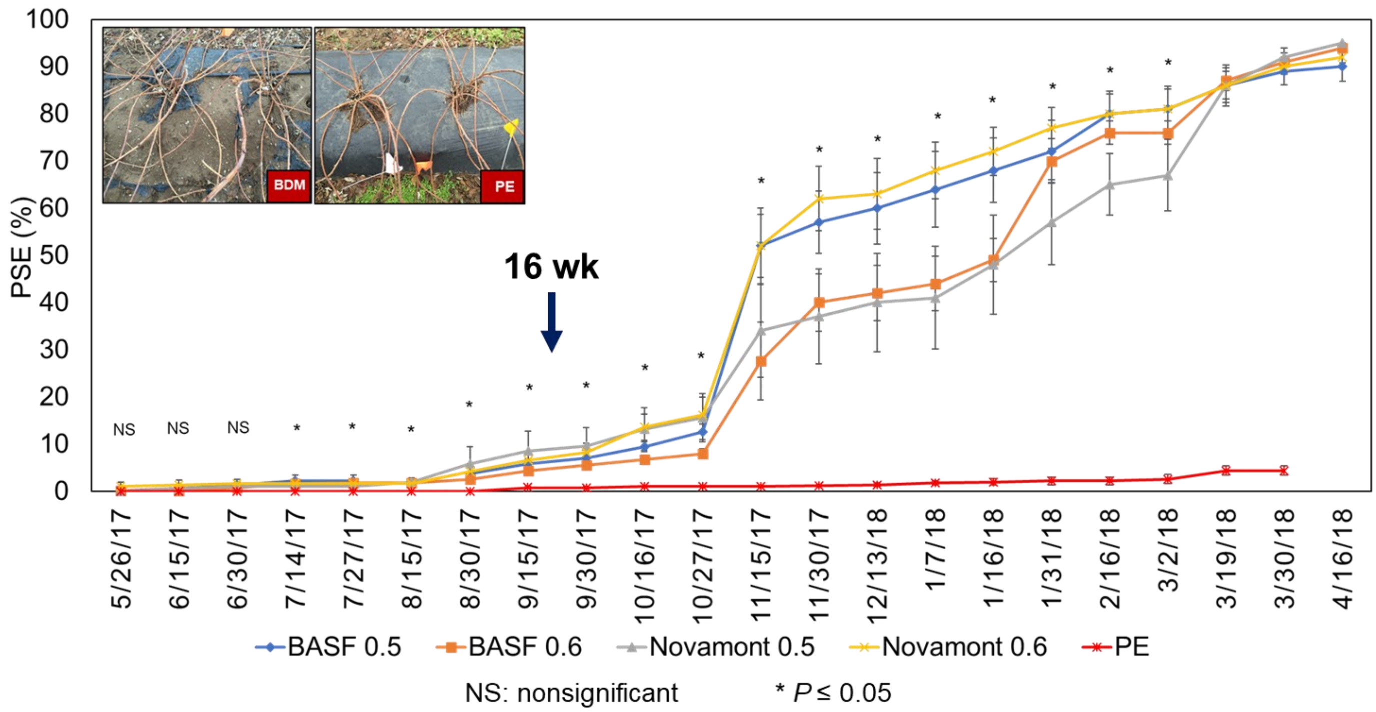

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Figure 3. PSE of mulch (0.5 = 12.7 µm thickness, 0.6 = 15.2 µm thickness) in raspberry production in Lynden, WA; 0% = completely intact, 100% = fully deteriorated, ratings in 1% increments up to 20%, and 5% increments thereafter; error bar is ± one standard error of the mean.

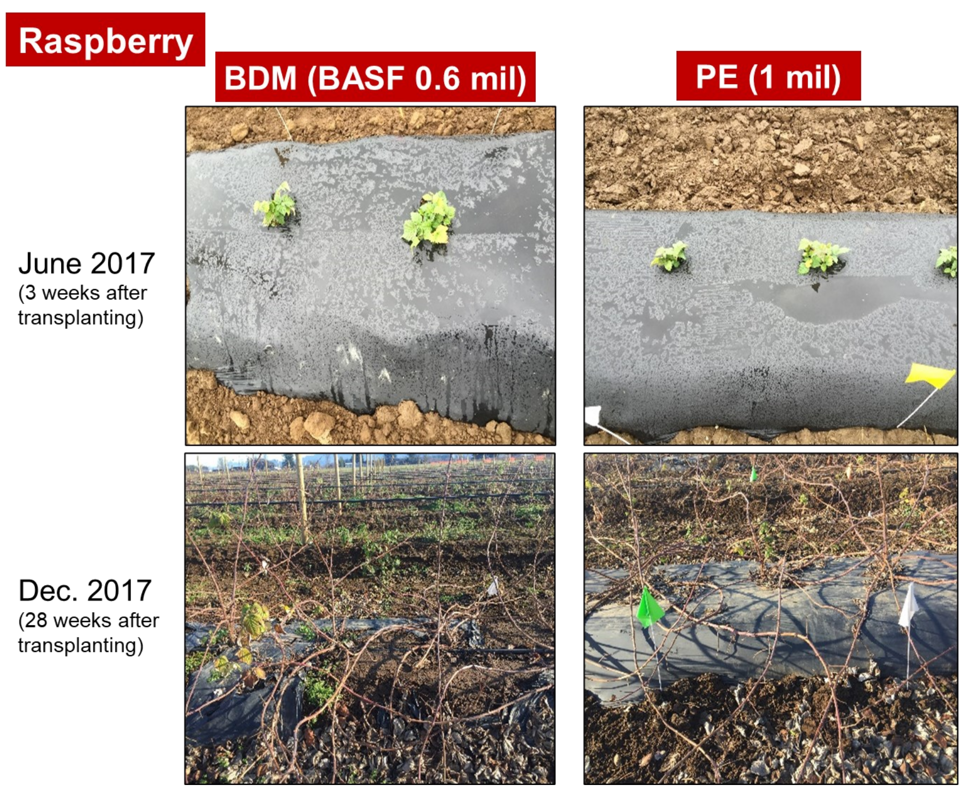

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Figure 4. Comparison of BDM and PE mulch during raspberry production.

Table 3. Crop production with BDM.

	Yield		Weed Control
Crop	**vs. Bare ground**	**vs. PE**	**vs. PE**
Broccoli	+[1]		
Cucumber	+	=	=
Eggplant	+	=	-
Lettuce		-=[2]	
Melon	+	+=	≅
Pepper	=	=	-
Pumpkin		=	=
Raspberry	+	=	=
Strawberry	+	-=+[2]	-
Sweet Corn	+	-=	-
Sweet Potato	+	+=	+
Tomato	+	=	≅
Zucchini		=	

[1] + BDM performed better; = BDM performed equivalent to; - BDM did not perform as well; empty cell not measured.

[2] Reports provide variable results.

Adapted from Cowan and Miles, 2018

Resources

These information resources provide background information and additional information to help you have a more thorough understanding of this topic. We encourage presenters to view each one so as to be better prepared for your presentation.

DeVetter, L.W., H. Zhang, S. Ghimire, S. Watkinson, and C.A. Miles. 2017. Plastic biodegradable mulches reduce weeds and promote crop growth in day-neutral strawberry in western Washington. HortScience 52:1700-1706.

Ghimire, S., E. Scheenstra, and C.A. Miles. 2020. Soil-biodegradable mulches for growth and yield of sweet corn in Mediterranean-type climate. HortScience 55:317-325.

Ghimire, S., A.L. Wszelaki, J.C. Moore, D.A. Inglis, and C. Miles. 2018. The use of biodegradable mulches in pie pumpkin crop production in two diverse climates. HortScience 53:288-294. https://doi.org/10.21273/HORTSCI12630-17.

Moore, J. C. and Wszelaki, A. L. (2019). The use of biodegradable mulches in pepper production in the Southeastern United States. *HortScience* 54, 1031–1038.

Video – 2019 SFC Raspberry Talk (start at 10 minutes) https://www.youtube.com/watch?v=W5J-P_32MGQ&feature=youtu.be.

Zhang, H., L.W. DeVetter, E. Scheenstra, and C. Miles. 2020. Weed pressure, yield, and adhesion of soil-biodegradable mulches with pie pumpkin (*Cucurbita pepo*). HortScience 55: 1014-1021 https://doi.org/10.21273/HORTSCI15017-20.