



Managing Biodegradable Mulch Films: Lessons from the Lab, Greenhouse, and Field



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Background

- Mulch films suppress weeds, control soil temperature, retain water, reduce nutrient leaching, and prevent crop-soil contact.
- Polyethylene films (material of garbage or grocery bag) are used most extensively. Annual cost of removal and disposal: \$400±\$100 /ac.
- Biodegradable mulch films can be incorporated into soil after each season. Various compositions are currently available including Bio360™ made of MaterBi™ biodegradable plastic resin (BP), and WeedGuard Plus™ made of paper (PA). New mulches are under development including papers that include degradable polyester fiber for increased strength and persistence, and polylactic acid (PLA) fabric loaded with organic particles of alfalfa, soy, or wood.

Experiment: Mulches were treated with biostimulants and buried in soil in sealed jars (tables 1 and 2). We measured respiration (CO₂ production) and mulch mass loss.

Results: Mulch type had the greatest influence on mass lost after 16 weeks; PA was completely decomposed (figure 1) while mass was unchanged for PLA (figure 1) and BP. Mass loss in PLA-A and PLA-S was increased significantly by Extract PBA and Biocat 1000, respectively (figure 2). No significant biostimulant effect was found on respiration for any mulch (data not shown).

Figure 1: Total degradation of PA (left). No mass loss of PLA, slight hydrophobicity visible (center). Cleaned PLA-S showing near complete loss of soy particles with only PLA remaining.

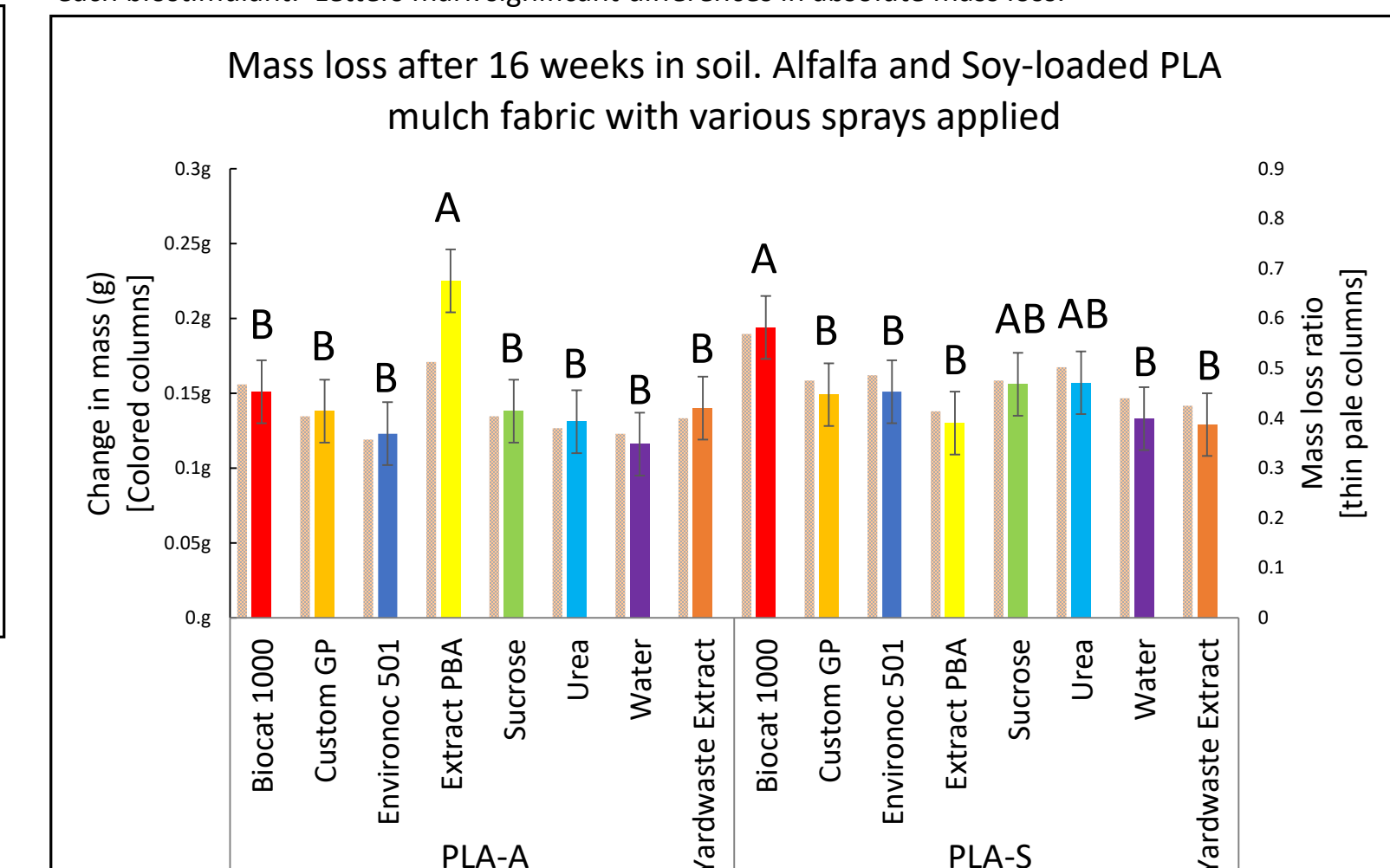


Lesson: Choice of mulch type, rather than biostimulant, will have greatest impact on mulch degradation in soil

| Product | Supplier | Mode of action | Application rate |
|---------------------------|-------------------|--|------------------|
| Biocat 1000 | Chandler | 6% N, micronutrients Mg, S, B, Cu, Fe, Mn, Mo, Zn, and humates | 10 fl oz/ac |
| Extract PBA | Loveland Products | 6% N, 13% S | 248 fl oz/ac |
| Custom GP | CustomBio | <i>T. harzianum</i> , <i>T. viride</i> , <i>T. koningii</i> , and <i>T. polysporum</i> | 0.7 fl oz/ac |
| Environoc 501 | Biodyne Midwest | 25 strains of bacteria and fungi | 32 fl oz/ac |
| Yardwaste Compost Extract | - | humates, diverse microbes | 250 gal/ac |
| Urea | - | 46% N | 50 lb/ac |
| Sucrose | - | 42% C | 3 lb/ac |
| Water | - | - | - |

Table 1. Characteristics of biostimulant treatments and their suggested application rates.

Figure 2: Mulch squares of uniform area were weighed before and after incubation. Here, absolute and relative mass loss are shown for alfalfa and soy-loaded PLA mulch (PLA-A and PLA-S) treated with each biostimulant. Letters mark significant differences in absolute mass loss.



| Mulch | Material | C:N |
|------------------------|--------------------------------------|------|
| Bio 360 (BP) | Plastic film from starch & petroleum | ** |
| WeedGuard Plus (PA)* | Paper | 302 |
| Polylactic acid (PLA)* | (100% PLA) | 1692 |
| PLA-Alfalfa* (PLA-A) | (30% PLA/70% Alfalfa) | 35 |
| PLA-Soy* (PLA-S) | (37% PLA/63% Soy meal) | 14 |

Table 2. Mulches and their C:N ratio *100% bio-based **negligible N

Objectives

The purpose of this poster is to outline practical principles for choosing and managing biodegradable mulches. We selected findings from three studies to answer the following questions:

- Lab:** How rapidly can biodegradable mulches decompose? Can biostimulants accelerate the process?
- Greenhouse:** Might soil-incorporated mulch residue affect subsequent crop yield? If so, how? Can compost extracts (CE) sprayed onto mulch before incorporation influence this relationship?
- Field:** Do different mulch types result in differences in crop yield during mulch working life and after soil incorporation in the field? Will biodegradable mulches really decompose within two years?

Experiment: Lettuce growth was measured in in greenhouse soil mix with 5 residues (alfalfa, straw, wood-particle-loaded PLA mulch [PLA-W], geotextile, none) treated with 5 sprays (table 3). Lettuce seeds were sown in 4" pots, harvested 42 days later.



Figure 3: CE was prepared by kneading 100g dry equivalent mass compost in a 450um nylon mesh bag submerged in 1000mL total water.

Results & Discussion: No yield difference between controls (geotextile & no residue) indicates no effect due to physical traits of soil/mulch mixture. PLA-W reduced lettuce growth, and straw reduced growth further (figures 3&4), but at harvest no difference in soil NO₃ was present between straw, PLA-W, or controls. 3lb/ac total N was supplied by sprays, it was mostly organically bound in CE but soluble in urea which increased yield compared to other sprays when averaging across residues (figure 4).

Our results suggest that the PLA-W and straw suppressed lettuce growth by N immobilization. But given 66 days of soil contact, neither straw or PLA-W reduced N availability compared to controls.

Lesson: In some circumstances biodegradable mulches may 'tie up' nutrients when incorporated into soil. Be wary of nutrient restriction especially in infertile soils, when a new crop immediately follows mulch incorporation, and if mulch is fairly unweathered when incorporated.

Greenhouse

| ID | Compost | Type | Feedstock |
|-------|---------------|-------------------|-------------------------------------|
| EK | EKO | Bagged | Poultry bedding, wood |
| SD | Dynamics | Local Windrow | Yard waste, zoo poo, kitchen scraps |
| BW | Backyard Worm | Home Worm Compost | Kitchen scraps, leaves, wood |
| urea | - | Dissolved | {Control for N effect} |
| water | - | - | {No spray control} |

Table 3. CE sprays applied to residues before soil incorporation. Compost origins, and controls. All sprays except "water" were applied at rates to deliver 3lb/ac total N.

Mean Lettuce Dry Weight; Low N Residues

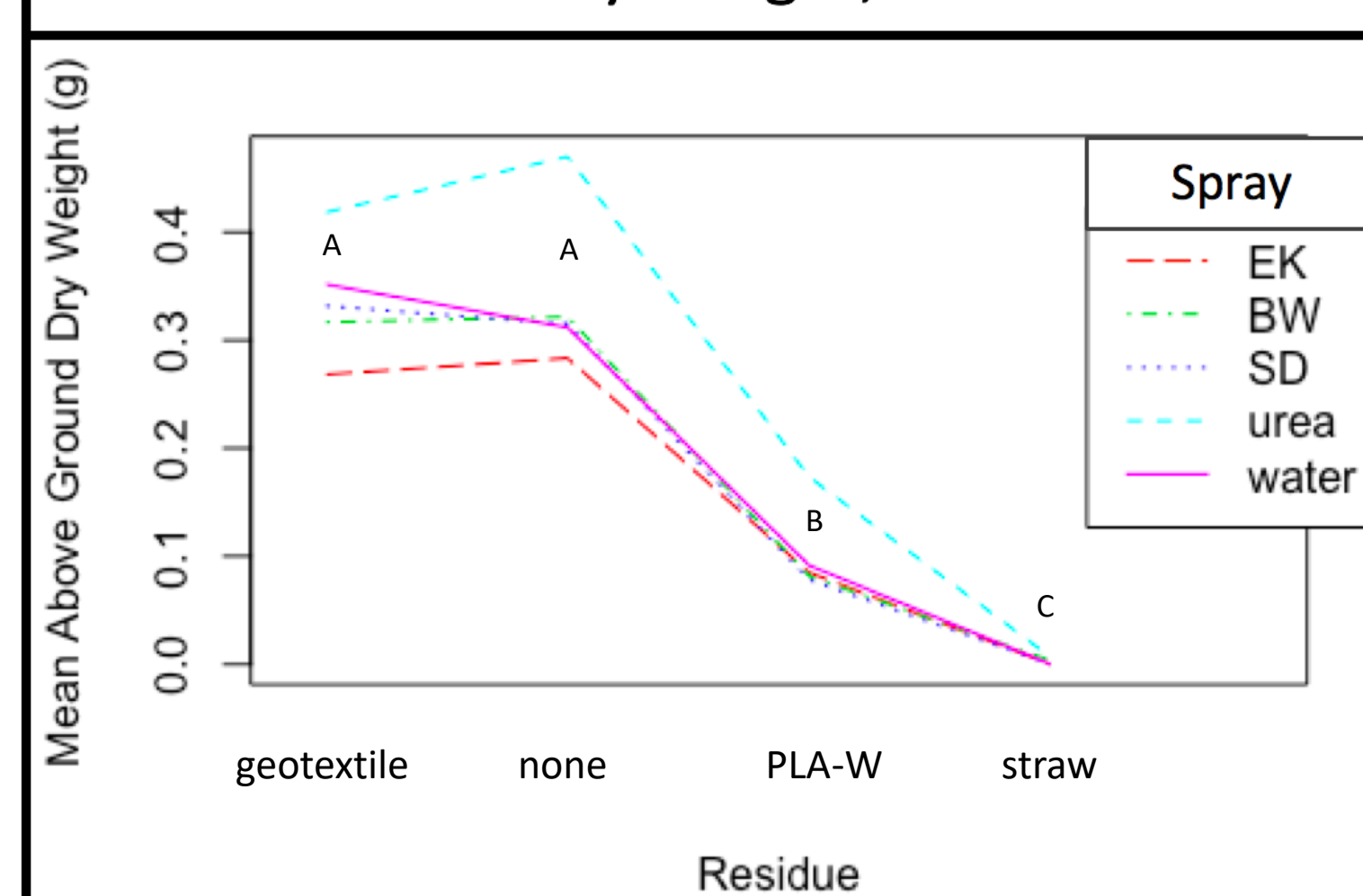


Figure 3: One of six blocks in the greenhouse study. Main effects of residue are evident. The five large plants received 5 ton/ac alfalfa (included to simulate a green manure cover crop, in this case CE affected lettuce growth but it is irrelevant to this poster, data not shown.)

Figure 4: Interaction plot. Letters show significant difference due to residue on lettuce growth. No differences due to any of the five sprays were present within each residue. A contrast comparing urea against all other sprays finds significant growth effect of urea.

Field

Experiment: 2017 yields of sweet pepper were compared using PLA-W and BP mulch at two Nebraska sites, Scottsbluff and Lincoln. In October 2017 mulches were incorporated by spader (in) or removed (off) to test the effect of mulch incorporation on subsequent 2018 sweet corn crop. Neither crop's yield was affected by mulch type, and incorporation versus mulch removal had no effect on the 2018 sweet corn yields (Figure 8). Similar findings have been reported by other authors as well.

Lesson: Mulch choice has less impact on crop performance, and more impact on persistence in soil. Choosing among biodegradable mulches should be based on cost and compatibility with systems in place for installation and tillage rather than expectations of yield effect.



Figure 5: The spader did not get tangled with either PLA-W or BP mulch, as rototillers have been reported to do.



Figure 6: Left: BP, small holes made by coarse crop residue allowed a few weeds to grow in rows. Center: PLA-W. Right: PLA-W after incorporation by spader, weeds, mustard cover crop and wildlife were undeterred by fabric-like residue.



Figure 7: Top: one year after burial PLA-W is in-tact, bottom BP was visible but too deteriorated to recover. Final samples to be recovered Fall 2019.

Figure 8: Boxplots showing yield difference by location (Scottsbluff, NE [SB] and Lincoln NE [LNK]). No yield difference was due to mulch type (PLA-W and BP) in mulched 2017 peppers or the following sweet corn crop whether mulch was incorporated (in) or removed (off) from soil.

