Determining the Herbicidal Potential of Bio-based, Sprayable Films in a Controlled Environment

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Background

- Bio-based, sprayable mulch may be a more sustainable and biodegradable option to plastic agricultural films and mulches.
- The physical and mechanical properties of bio-based mulches have been tested in recent years, but little is known about their potential to suppress broadleaf weeds.
- While organic herbicides exist, there is room for improvement as they are often expensive and require high rates with multiple applications.
- The objective of this experiment was to determine the phytotoxic potential of bio-based films and to quantify the effect of application rates on weed mortality of a broadleaf species: velvetleaf (*Abutilon theophrasti)*.

Methods

Lab Study

- 9 solutions were prepared in a petri dish, varying among 8 total ingredients, and physical properties (shrinking, cracking, absorptivity) were measured
- A 5 ingredient solution with the fewest cracks was selected for a greenhouse trial, along with a solution containing all ingredients for comparison:

<u>5 ingredient solution</u>

77% water
15% glycerol
4% corn starch
2% corn gluten meal
2% isolated soy protein

<u>8 ingredient solution</u>

63% water
23.5% glycerol
6% corn starch
2% eggshell powder
1.5% corn gluten meal
1.5% isolated soy protein
1.5% corn zein
1.5% hydrolyzed chicken feathers (keratin)

Greenhouse Study

- Randomized complete block design with 4 replications and 3 factors (2 solutions, 3 application rates, and 3 application times)
  - Per replication: 20 pots = 18 treatments and 2 controls
- 20 velvetleaf seeds were planted in each pot
- Plants were grown for a 3 week period
- 24 hours after planting, pre-emergence treatments were applied to selected pots
- Pots receiving post-emergent treatments were reduced to 3 plants per pot
- A post-emergence treatment was applied to selected pots at the VE and V1 velvetleaf growth stages
- Pots received no water within 48 hours of treatment application to allow time for films to dry
- Weed density and dried biomass were measured for each pot

Figure 1. The 5 ingredient solution. This film had the fewest cracks among 9 solutions prepared in petri dishes.

Figure 2. The sprayer used to apply bio-based film solutions. Rates were calibrated using a graduated cylinder and a stopwatch.

Figure 3. One replication of 4 of the Greenhouse trial. The 20 pots were arranged randomly, each receiving a different treatment.

Figure 4. Pre-emergent treatment results for the 8 ingredient solution. Pots from left to right: 0 gal/ft^2, 0.05 gal/ft^2, 0.12 gal/ft^2, 0.24 gal/ft^2.

Figure 5. Pre-emergent treatment results for the 5 ingredient solution. From left to right: 0 gal/ft^2, 0.05 gal/ft^2, 0.12 gal/ft^2, 0.24 gal/ft^2.

Figure 6. VE/VC treatment results for the 8 ingredient solution. From left to right: 0 gal/ft^2, 0.05 gal/ft^2, 0.12 gal/ft^2, 0.24 gal/ft^2.

Figure 7. VE/VC treatment results for the 5 ingredient solution. From left to right: 0 gal/ft^2, 0.05 gal/ft^2, 0.12 gal/ft^2, 0.24 gal/ft^2.

Figure 8. V1/V2 treatment results for the 8 ingredient solution. From left to right: 0 gal/ft^2, 0.05 gal/ft^2, 0.12 gal/ft^2, 0.24 gal/ft^2.

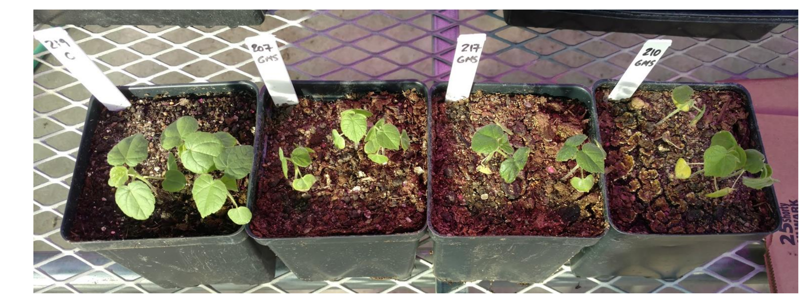

Figure 9. V1/V2 treatment results for the 5 ingredient solution. From left to right: 0 gal/ft^2, 0.05 gal/ft^2, 0.12 gal/ft^2, 0.24 gal/ft^2.

Results

- Films from both solutions had many physical cracks after drying
- The 8 ingredient solution and the 5 ingredient solution both significantly reduced weed biomass ($p<0.001$) at 0.05 gal/ft^2 for Pre and VE-Post applications

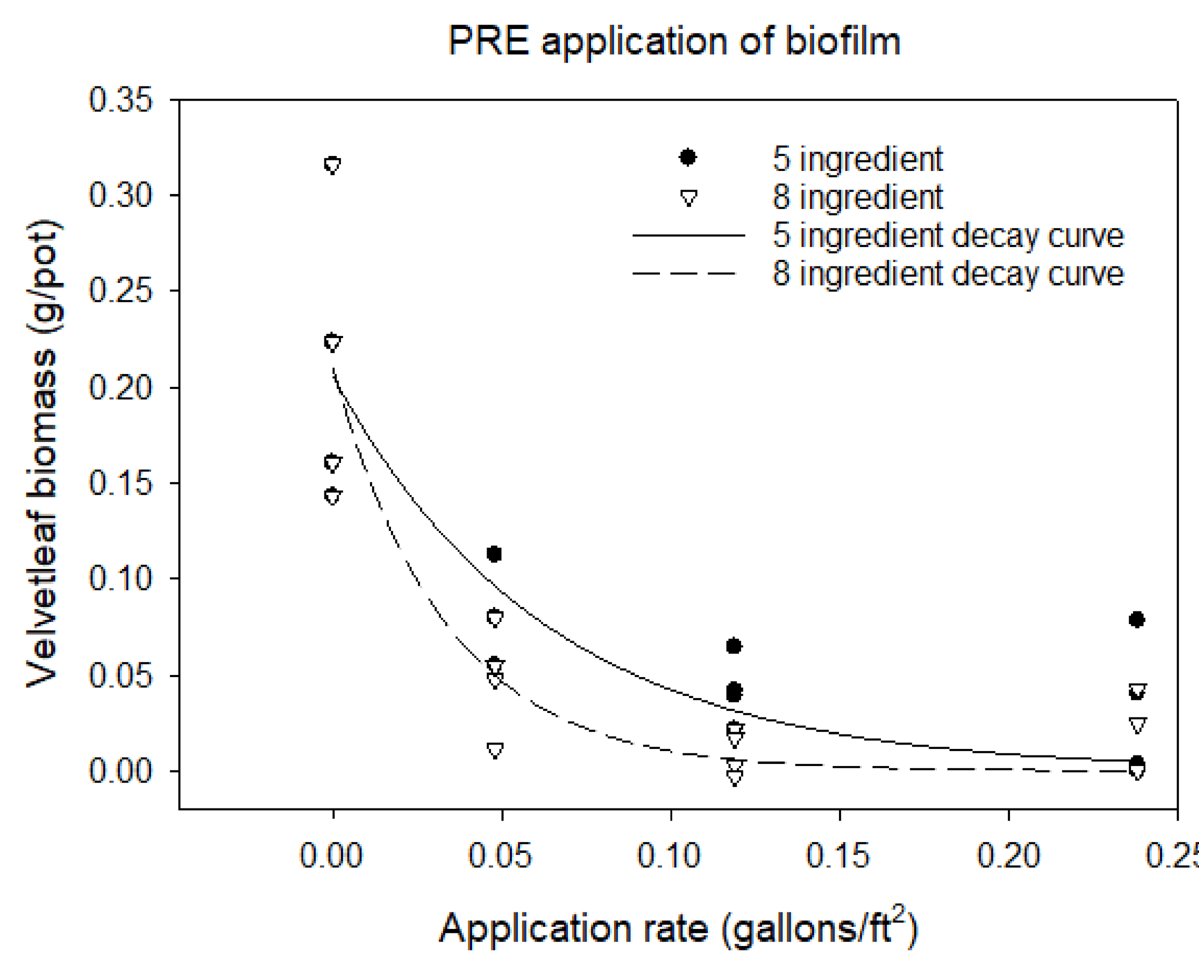

Figure 10. Effect of two biofilm solutions at 4 different rates on a broadleaf weed species, velvetleaf, prior to plant emergence in a greenhouse environment at UNL.

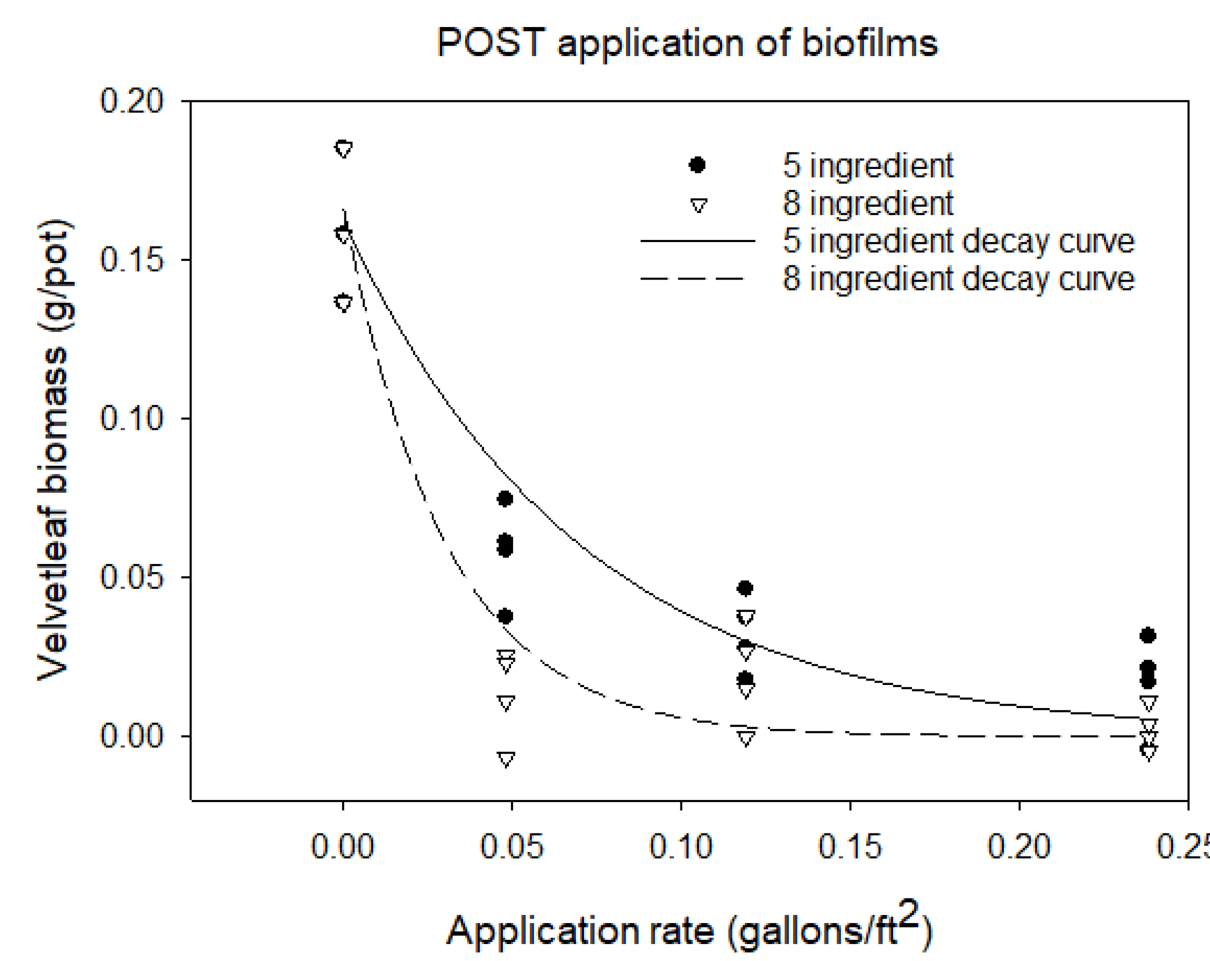

Figure 11. Effect of two biofilm solutions applied at 4 different rates on a broadleaf weed species, velvetleaf, after plant emergence in a greenhouse environment at UNL.

Conclusions

- The ability of the 8 ingredient solution to suppress weed growth despite many cracks suggests phytotoxic potential from one or more of the ingredients
- Based on the greenhouse experiment results, 0.05 – 0.1 gal/ft^2 rates can be converted for possible field applications:
  - 1 acre of tomatoes (6' rows): 120-240 gallons to spray a 4" band in the crop row
  - 1 acre of green beans (3' rows): 240-480 gallons to spray a 4" band in the row
  - 1 acre of hops (12' rows): 180-360 gallons to spray a 12" band in the row
  - Cost = ??? Experimental, research grade ingredients are expensive, but most could be sourced raw/bulk for less
- Next steps: Decrease cracking of film on soil, increase phytotoxicity, and reduce water content of solutions
  - Team of engineering students working to design a sprayer/applicator to handle these highly viscous solutions
  - Also exploring different application methods of ingredients, including powders, granules, and films from extrusion

Figure 12. Product from extrusion of ingredients, completed at the University of Nebraska-Lincoln Food science department. Grinding of this product will result in a powder to be tested on a broadleaf weed species.

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