Biodegradable Films as an Alternative to Plastic Mulch in Strawberry Production

Progress Report for SRSFC Project #2007-08

Research Proposal

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Objective:

To determine the durability and affordability of biodegradable films as an alternative to traditional polyethylene plastic mulches in strawberry production.

Justification:

Strawberries produced using the annual hill system are typically grown in raised beds covered with black plastic mulch. The black plastic offers a number of benefits, such as weed control, disease protection, and optimization of soil temperature and moisture, yet there are a number of disadvantages with its use. The main problems with polyethylene plastic mulches are: (i) they need to be removed from the field at the end of the season, (ii) they are made from non-renewable resources (petroleum), and (iii) disposal can be expensive and is an environmental problem.

Biodegradable films or bioplastics can be used in place of polyethylene mulch. These materials can be tilled in the soil, resulting in reduced labor input, landfill charges, and solid waste. Right now biodegradable films are more expensive than black plastic; however, the quality and supply of these films is steadily increasing. Bioplastics are made from renewable resources, and if adoption of the technology increases, biodegradable mulches may become more affordable than polyethylene.

Methodology:

We are testing 4 different biodegradable mulches against a 1.25 mil black polyethylene control in a randomized complete block design (4 reps/treatment).

Biodegradable Mulches:

- 0.6 mil black BioTELO (Distributed by Dubois Agrinovation, Quebec, Canada. www.duboisag.com)
- 0.8 mil black BioTELO (Distributed by Dubois Agrinovation, Quebec, Canada. www.duboisag.com)
- 1.0 mil black Ecofilm (Cortec Corporation, St. Paul, MN. www.ecofilm.com)
- 0.70 mil black BioBag AgroFilm Commercial (BIOgroupUSA, Inc., Palm Harbor, FL. www.biobagusa.com)

Mulch materials (4 foot wide) were applied to the soil at the Plateau Research and Education Center in Crossville, TN on September 10, 2007 using a 6-inch bed-forming mulch layer. The soil had a pH of 6.3 and was extremely dry.

'Sweet Charlie' strawberry plugs were transplanted on September 25, 2007. Plants were spaced 12 inches apart in double rows 16 inches apart in plots 25 feet long. Fertility is being managed by fertigation through the drip tape. Annual ryegrass was sown in the aisles, and electric fencing was set up around the perimeter of the plot (Fig. 1). Soil temperature sensors were placed in each treatment at a 4-inch depth. Floating row covers were placed over all treatments in mid-December.

Results:

Application of mulch materials

With the exception of the BioBag material, all biodegradable films laid as well as the polyethylene plastic did (Figs 2A-E). Four problems were encountered with the BioBag mulch: (a) the material was damaged (punctured) during shipping, and ~100-150 feet needed to be removed, (b) the interior cardboard cylinder for the 4-foot roll was too wide for the mulch layer (Fig. 3A), (c) the mulch was weak and consistently broke from the roll when laying (Fig. 2E), and (4) the wheels on the mulch layer tended to damage the plastic on the bed shoulders (Fig. 3B). It is important to note that we cut the cardboard cylinder to a correct length, and removed sufficient damaged mulch from the BioBag roll prior to application.

Longevity of mulch materials

September 25, 2007: 15 days after application. At the time of transplanting (15 days after the mulches were laid) all of the mulch films except the BioBag material were intact and did not visible signs of degradation (Figs. 4A-E). The BioBag mulch had begun to rip in a number of places, and most replicates showed signs of degradation.

October 24, 2007: 44 days after application. Some small holes appeared and a few weeds began to emerge in all materials, including the polyethylene plastic (Figs. 5A-E). With the exception of the BioBag film, it did not appear as though the biodegradable mulches were beginning to degrade or lacking strength. The BioBag material, on the other hand, was very degraded in all replicates (<50% degradation).

December 12, 2007: 89 days after application. All mulches appear to be in the same condition as they were on Oct. 24th (Figs. 6A-E). A number of ryegrass volunteers have emerged in all treatments, and cool-season weed pressure is becoming a problem in

the holes made for the strawberry transplants. We requested that the plots be weeded by hand prior to applying the floating row covers.

Conclusions

Durability

At this point in the trial it appears that the 0.6 mil BioTELO, 0.8 mil BioTELO, and 1.0 mil Ecofilm perform as well as the 1.25 mil polyethylene plastic. The BioBag material did not apply to the soil easily or reliably, and it degrades too rapidly to be used for annual strawberry production. Our preliminary conclusions are based on: (i) ease of application using a mulch-layer, and (ii) visible degradation. Future determination of yield, analysis of soil temperature data, and observation of mulch degradation after harvest will help provide more detailed conclusions and recommendations.

We contacted representatives from BIOgroupUSA, Inc. to discuss the problems we encountered with the BioBag mulch. They claim that our observations are not typical, and that the "film quality was compromised", most likely because it was ordered at the end of the [warm] season. They suggested that the tension on the mulch-layer was not set correctly; however, both the BioTELO and BioBag mulches are made from the starch-based Mater-Bi™ material, and the BioTELO products laid very well using our mulch-layer. This suggests that there was a specific problem with the BioBag material, and when we take into account the rapid degradation of this film compared to the others, it is clear that quality was compromised.

BIOgroupUSA sent us a new biodegradable material designed for long-term, cool-season crops. We intended to lay this mulch next to the current trial, and observe degradation/durability without any plants. Unfortunately, continuous rainy weather has prohibited us from working the field and laying the mulch this year.

Our experience with the Biobag material has brought up a new question. What is the "shelf-life" of some of the biodegradable mulches, and if they are produced annually with the intent on being applied in the spring, will strawberry growers receive a consistent product? If we conclude that some of the biodegradable films can be used in place of polyethylene plastic for strawberry production, future research should involve testing the mechanical properties (burst strength, tensile force, tear strength, elongation-to-break, and load-to-break) of a number of rolls/manufacturer over the season. Additionally, a number of other degradable/biodegradable/compostable materials have recently been discovered, and these materials should also be tested for use in strawberry production.

Affordability

The biodegradable mulches are approximately 2 to 3 times more expensive than the polyethylene plastic (Table 1). However, this is simply the cost to purchase the material, and does take into account the removal and disposal expenses for the nondegradable plastic mulches.

Table 1. Cost of mulch films

Mulch Product	Thickness (mil)	Cost per Acre[a,b]
BioTELO	0.6	**$484**
BioTELO	0.8	**$644**
BioBag	0.7	**$543**
Ecofilm	1.0	*
Plastic	1.25	**$220**

[a]Prices do not include shipping. Cost for shipping 4 rolls of BioTELO was $258 and 1 roll of BioBag was $35.27.
[b]Calculated using 6 feet between rows of a 4 foot wide material.
*This was a sample roll and is not yet commercially available.

Figure 1. Plot layout at the Plateau Research and Education Center in Crossville, TN.

Figure 2. Applying mulch films to the soil: (A) 1.25 mil polyethylene, (B) 1.0 mil Ecofilm, (C) 0.8 mil BioTELO, (D) 0.6 mil BioTELO, and (E) 0.7 mil BioBag.

Figure 3. (A) Cutting the cardboard cylinder on the 4 foot roll of 0.7 mil BioBag to fit in a 4 foot mulch layer; (B) Damage to the shoulders of the beds covered with 0.7 mil BioBag.

Figure 4. Representative mulch films 15 days after application (Sept 25, 2007): (A) 1.25 mil polyethylene, (B) 1.0 mil Ecofilm, (C) 0.8 mil BioTELO, (D) 0.6 mil BioTELO, and (E) 0.7 mil BioBag.

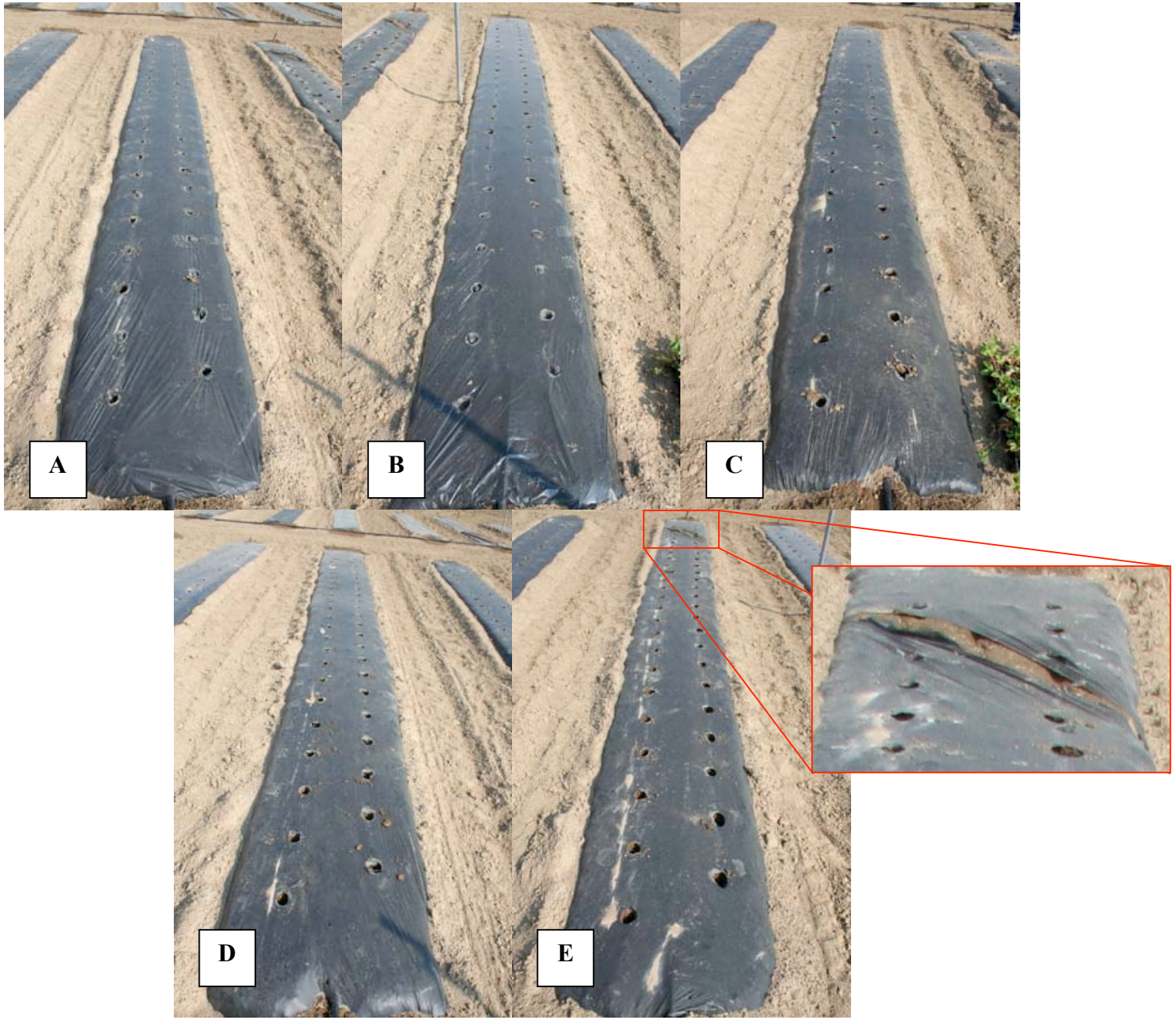

Figure 5. Representative mulch films 44 days after application (Oct. 24, 2007): (A) 1.25 mil polyethylene, (B) 1.0 mil Ecofilm, (C) 0.8 mil BioTELO, (D) 0.6 mil BioTELO, and (E) 0.7 mil BioBag.

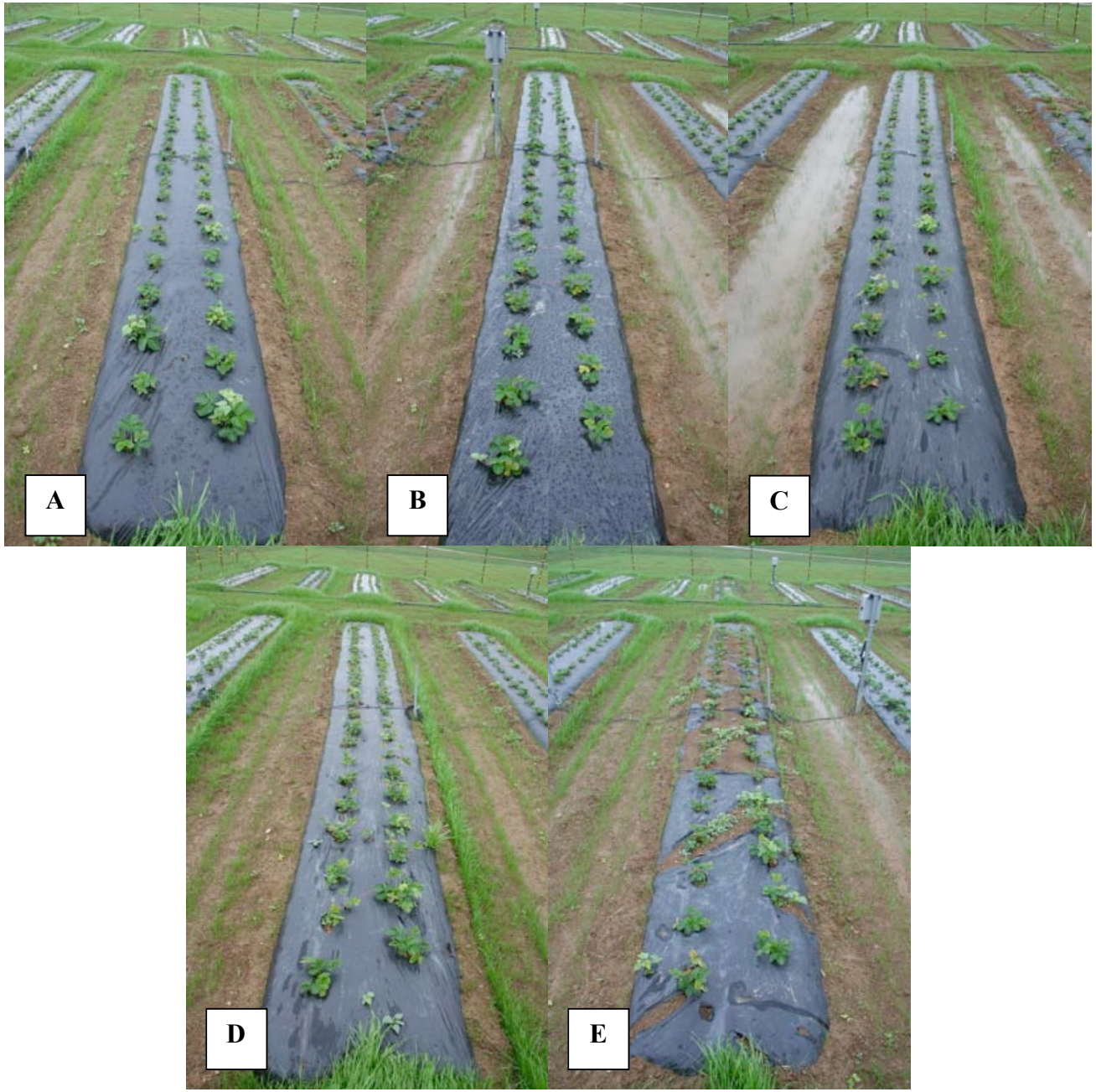

Figure 6. Representative mulch films 89 days after application (Dec. 12, 2007): (A) 1.25 mil polyethylene, (B) 1.0 mil Ecofilm, (C) 0.8 mil BioTELO, (D) 0.6 mil BioTELO, and (E) 0.7 mil BioBag.