Searching for Alternatives to Plastic Mulch

Carol Miles, Lydia Garth[1], Madhu Sonde, and Martin Nicholson, WSU Vancouver Research and Extension Unit, 1919 NE 78th Street, Vancouver, Washington; (360) 576-6030, milesc@wsu.edu, http://agsyst.wsu.edu

Introduction

The first man-made plastic was unveiled by Alexander Parkes in 1862, and since then plastics have led to advances in medicine and healthcare, innovations in packaging and products, and have become common place in our homes, offices, schools and almost every walk of our lives. Plasticulture, the use of plastics in agriculture, began in the 1950s and includes plastic mulches, greenhouse plastic, pots and plug trays, as well as irrigation pipe and tape. Since its introduction into agriculture, plastic has contributed significantly to the economic viability of farmers worldwide. The use of plastic mulch has become a standard practice for all vegetable farmers who benefit from reduced evaporation, weed control, reduced fertilizer leaching and soil compaction, as well as elevated soil temperatures that promote earlier plant maturity.

Though very effective and affordable, plastic mulch has become an environmental management concern due to disposal issues. On-site disposal options such as open burning and on-site dumping are environmental liabilities, and recycling of dirty plastics is not an economically feasible option. The disposal option that most growers choose is the landfill. In 1999, almost 30 million acres worldwide were covered with plastic mulch. More than 185,000 of those acres were in the United States, and essentially all of this plastic entered the waste stream. An effective and affordable alternative to plastic mulch would contribute the same production benefits as plastic mulch and in addition would reduce non-recyclable and non-renewable waste. In 2003, we began to investigate alternatives to plastic mulch in vegetable production at the WSU Vancouver Research and Extension Unit.

Materials and Methods

Our study included six mulch treatments: Garden Bio-Film, brown paper, paper + linseed oil, paper + tung oil, paper + soybean oil, and black plastic (control). In this study we used end rolls of 26 lb. kraft paper, similar to what is used to make paper grocery sacks. End rolls are left over from industrial orders and their price varies seasonally. The purpose of the oil application is to reduce the rate of paper degradation in the field. It is unclear if certain oils may be more effective than others. A thin film of oil was applied evenly over the entire surface of the paper. Oil was sprayed onto the paper prior to laying the paper in the field so that the edges of the paper where there is contact with the soil (the most likely site of degradation) would be coated with oil.

The experimental design of this study was a randomized complete block with four replications. Plots were 10 feet long and one bed wide, with two rows of drip tape laid under the mulch treatments. Paper and plastic mulch were laid in the field using conventional mulch laying equipment (Figure 1). Garden Bio-Film was laid by hand as the product we received from the

[1] Lydia Garth is a senior at Columbia River High School in Vancouver and she participated on this study as part of her senior science project.

manufacturer was packaged for home gardeners and was not compatible with our equipment. The manufacturer will package product for commercial use if there is demand. Two rows of six varieties of basil were planted in each plot on June 25 (Figure 2). We measured plant height and the quality of the mulches throughout the season, and we measured plant fresh weight and plant dry weight at harvest. In August and September, we measured air temperature under some of the mulch treatments.

Figure 1. Laying paper mulch with conventional mulch laying equipment; drip tape was laid at the same time in 2 rows under the mulch.

Figure 2. Basil planted in 2 rows 10 feet long per plot; drip tape was laid under the mulch along each row of basil.

Results and Discussion

In this study the six basil varieties differed significantly in height and weight, but there was no interaction between variety and mulch treatment. That is, all six basil varieties responded in the same manner to each mulch treatment. Therefore we will only discuss the effects of mulch treatments on basil in general.

Plant Height. Plant height (cm) was measured weekly in August. Plant height differed significantly among treatments, and the Garden Bio-Film mulch treatment resulted in taller plants throughout the growing season (Table 1). Plant height in all of the paper mulch treatments did not differ from plant height in the black plastic mulch treatment at any time. Additionally, the type of oil applied to the paper had no affect on plant height. Plant height under the black plastic mulch was low at the beginning of August but high at the end of August. The low plant height in early August may have been a result of high temperatures from late July through early August (temperatures during those 3 weeks were the highest all summer, up to 100 ^{o}F). In contrast, plant height under the paper plus soy oil was high at the beginning of August but low at the end of August (Figure 3). Plant height throughout the experiment declined in week two, likely because we followed common basil growing practices and pinched flowers each week to encourage foliage development. Removing the apical dominance in the plant induced lateral growth that resulted in heavier branches that were initially bent down, thus reducing the plant's height.

Table 1. Height of basil plants grown with 6 mulch treatments.

Treatment	5-Aug	12-Aug	20-Aug	26-Aug
Paper	23.2ab	16.9b	21.5b	23.5b
Paper + Tung	19.5ab	16.9b	21.3b	23.6b
Paper + Linseed	14.4b	17.3b	21.4b	23.4b
Paper + Soy	27.3ab	17.3b	21.6b	23.5b
Garden Bio-Film	29.4a	20.3a	25.0a	27.1ab
Black Plastic	17.4ab	20.0a	23.8ab	25.9ab
p Value	0.2012	0.0392	0.0667	0.1049

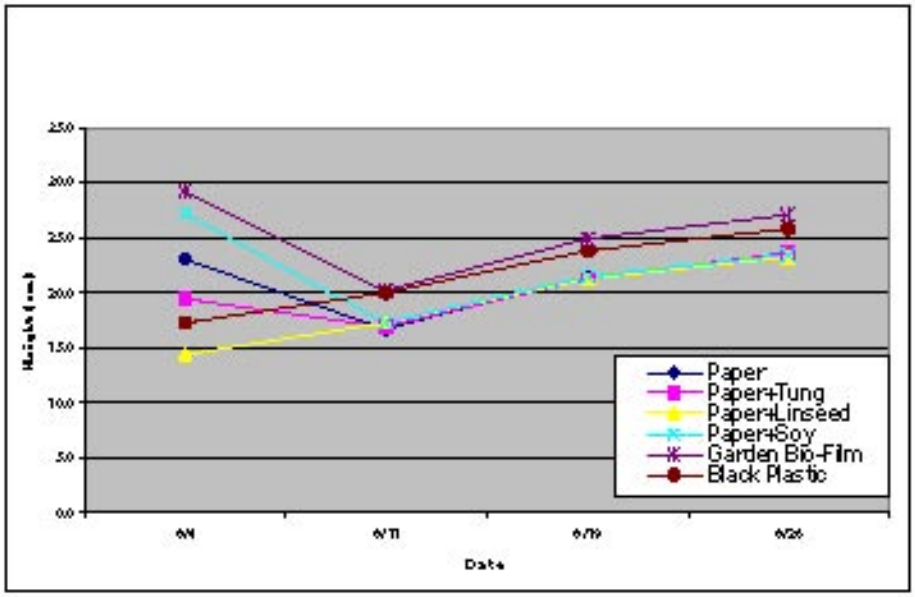

Figure 3. Height of basil grown with 6 different mulch treatments.

Plant Weights. Basil was harvested on August 25, and fresh and dry weights (g) were measured. Plant fresh weight and dry weight in the Garden Bio-Film mulch treatment tended to be the highest and weights in the black plastic treatment were second highest (Figure 4). However, these differences in fresh weight and dry weight were not significant (Table 2). Basil is a relatively short season crop and we harvested plants 8 weeks after transplanting. It is possible that a longer season crop would benefit more from the mulch treatments.

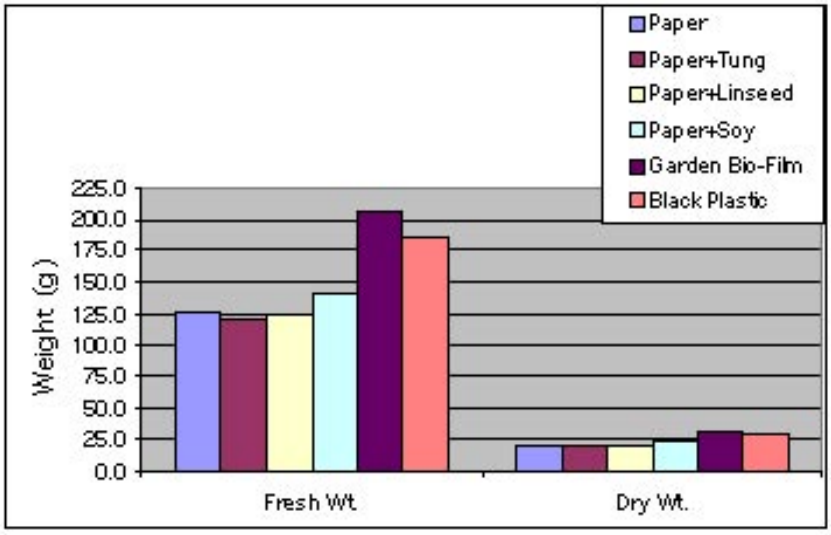

Figure 4. Fresh weight (g) and dry weight of basil grown with 6 mulch treatments

Table 2. Fresh weight (g) and dry weight of basil grown with 6 mulch treatments.

Treatment	Field Wt	Dry Wt.
Paper	126.0a	20.8a
Paper +Tung	118.9a	19.2a
Paper + Linseed	125.2a	20.5a
Paper + Soy	140.2a	23.7a
Garden Bio-Film	206.3a	32.1a
Black Plastic	185.9a	28.5a
p Value	0.4101	0.4173

Temperature. Temperature was measured under the paper (with no oil application) and the black plastic from August 6, and under the Garden Bio-Film from August 20 through September 3. We compared temperatures under the mulches to the temperature at the soil surface without mulch. Temperature fluctuated for each mulch treatment throughout the measurement period, so that no treatment consistently produced the highest or lowest temperature (Figure 5). From August 6 through August 12, temperatures were similar under the black plastic and paper mulches as compared to no mulch. From August 13 through August 21, day temperature where there was no mulch was approximately 5° F greater than under the paper mulch and 10° F greater than under the black plastic mulch. In general, the difference between day temperature and night temperature was greater where there was no mulch than for any of the mulch treatments.

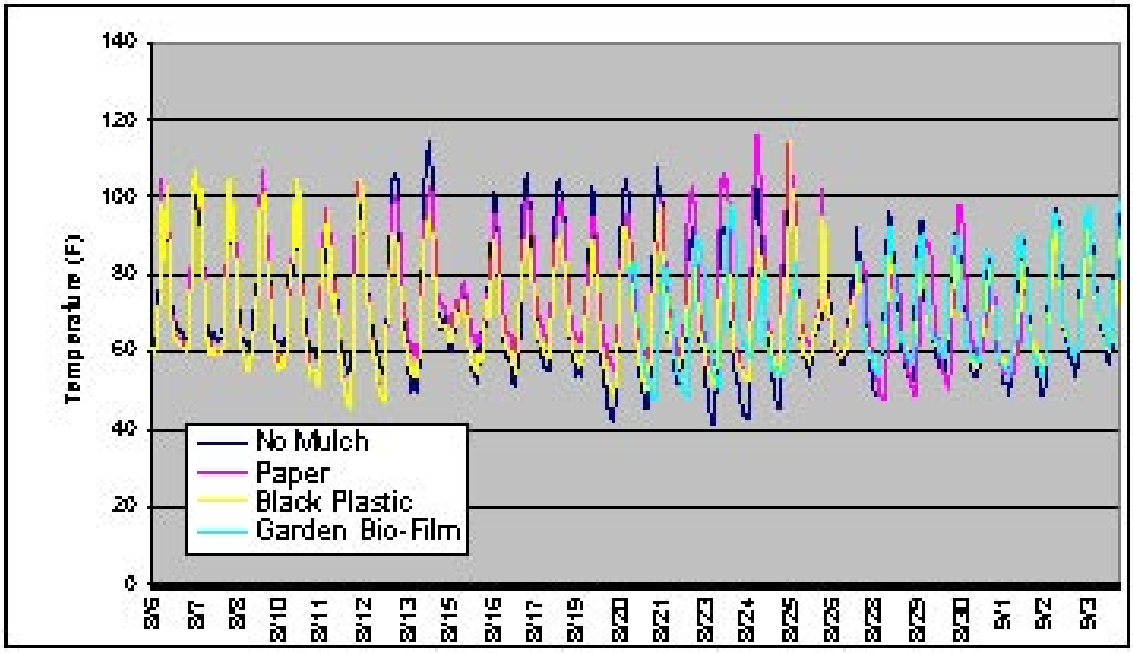

Figure 5. Temperature measured at the soil surface, under paper, black plastic, Garden Bio-Film and no mulch.

Mulch Quality. We rated mulches on a scale of 1-5 where 1 was completely disintegrated and 5 was completely intact. Ratings were based on the mulch's appearance including rips, holes, thin spots, water damage, mold, and weed growth. Ratings were done once a week throughout August. In this study there were no significant differences in mulch quality in the field due to the type of mulch. That is, all the mulches maintained their integrity throughout the study and weed control was excellent for all mulch treatments.

Garden Bio-Film and the black plastic mulches had the highest ratings on August 4 (4.4 and 4.0, respectively) while the paper mulches were all rated only slightly lower (3.6) (Figure 5). Garden Bio-Film steadily decreased in quality over the season and by August 25 was rated at 2.6, while black plastic only declined to 3.0 by the end of the study. Garden Bio-Film is designed to degrade in one growing season (90 days), thus the small rips and tears that we observed over the course of the study were normal. The Garden Bio-Film only began to partially degrade by the end of the study, but this did not affect plant growth or production, or weed control in this treatment.

The paper mulches, regardless of oil application, all had very similar and not significantly different ratings (3.0–3.6) throughout the experiment. Oil application had no effect on the quality of the paper mulch in the field over the course of this study. The paper we used in this study was 26 lb. and was thick and durable enough so that oil may not have been needed to increase its longevity. Or, we may not have applied sufficient oil to the paper to make a difference. The paper mulch, with or without oil, maintained its integrity and provided good weed control throughout the study.

It is important to note that much of the damage to the mulches that we observed was due to human error. Garden Bio-Film and the paper mulches were especially sensitive to any pressure or punctures caused by being walked on or poked with a hoe. Once damaged, the Garden

Bio-Film mulch ripped easily. The paper was only easy to damage when it was wet following irrigation. When the paper was dry, it did not puncture or rip easily. The papers sprayed with tung, linseed and soybean oil had a slight tendency to mold if they were damp on top, and this affected the quality and rating of the mulch. Having properly working drip irrigation and hot summers would eliminate this problem.

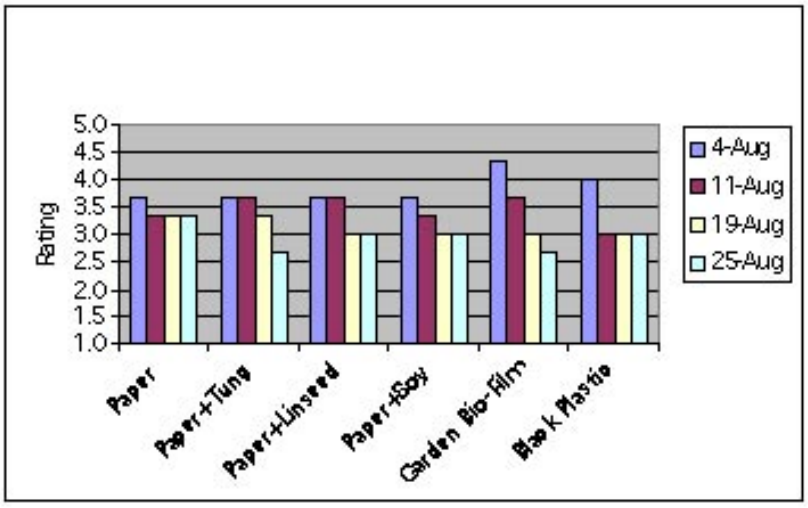

Figure 6. Ratings in the field of 6 mulches throughout August.

Conclusions

The purpose of this study was to determine if there are suitable alternatives to plastic mulch in regards to weed control and crop production in the Pacific Northwest. In this study we found that there were no differences in the quality or durability of the six mulch treatments or in the quality and yield of the vegetable crop. The oil had no effect on the longevity or qualities of the paper mulch. The paper mulches proved as high in quality as the plastic mulch and Garden Bio-Film. In adjacent observation plots, paper was laid in the field and then oils were applied. There was no difference in quality of the mulch whether oil was applied before or after laying the mulch in the field. In an additional adjacent observation plot, paper with no oil was laid in the field and overhead irrigation was applied throughout the summer. There was no difference in the quality of the mulch whether irrigation was applied through drip or overhead irrigation.

In 2004 we hope to continue to investigate alternatives to plastic mulch. We intend to test different weights of paper and we will again test Garden Bio-Film mulch. We will also evaluate the response of several types of vegetable crops to the different mulches. We will measure if crops that do best in high temperatures and crops that do best in cooler temperatures perform differently with the different mulches.

Sources of Mulch

Paper – Newark Paperboard Products
620 11th Ave, Longview, WA 98632
(360) 423- 3420
Attn: Jim McDaniel, General Manager

Garden Bio-Film – Biogroup USA, Inc.
107 Regents PI. Ponte Vedra Beach, FL 32802
(904) 280-5094; Fax: (904) 543-8113; http://www.biogroupusa.com

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