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Sustainable Plastic Mulch Options for Vegetable Production Systems

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Sustainable Plastic Mulch Options for Vegetable Production Systems

Abstract

The objective of this trial was to evaluate the use of Greenshift plastic mulch in a lettuce production system.

Keywords

Horticulture

Disciplines

Agricultural Science | Agriculture | Horticulture

Sustainable Plastic Mulch Options for Vegetable Production Systems

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Introduction

The objective of this trial was to evaluate the use of Greenshift plastic mulch in a lettuce production system.

Materials and Methods

On August 6, 2012, pelleted butterhead lettuce seeds (cv. Nancy) were seeded into a soil-less greenhouse medium (75% sphagnum peat moss and 25% perlite) in 98-celled flats (Figure 1).

Seedlings were grown in the greenhouse for four weeks, after which they were moved to the ISU Horticulture Research Station, Ames, Iowa, and placed underneath a lath house for hardening. The study was conducted on a Clarion Loam soil with 2-5 percent slope. On September 12, 2012, ground was tilled and raised beds were constructed using a plastic mulch layer. Lettuce was transplanted (Figure 2). The following treatments were tested:

1. Bare ground (no plastic mulch)
2. Black plastic mulch
3. Greenshift plastic mulch

In the plastic mulch treatment, beds were shaped 4 to 6 in. high and covered with either black or Greenshift plastic mulch (Figure 3). Beds were spaced 6 ft center-to-center. Each treatment comprised of 15-ft sections with two rows of lettuce plants. Each row had 12 plants with 12-in. spacing between rows and 10-in. spacing between plants. Thus, each treatment had 24 plants and was replicated four times.

Standard production practices for lettuce were employed. Crop was drip irrigated. During the growing season data were collected on plant area and leaf chlorophyll content. Light reflective readings also were taken three times to document the amount of light reflected from the surface of the plastic mulch and the bare ground treatment. Crop was harvested on November 9, 2012.

Data were collected on marketable weight and number, nonmarketable weight and number, leaf number/plant, leaf area/plant, and plant dry weight. To calculate leaf area, plants were completely stripped off and leaves passed through leaf area meter (L3100, LICOR Leaf Area Meter). Leaves then were dried in an oven until there was no change in weight. All data were analyzed using PROC MIXED function of SAS 9.2.

Results and Discussion

Greenshift plastic reflected significantly less light than black plastic or bare ground treatment (Table 1). Lettuce plants growing on either black or Greenshift plastic were visually more robust than the bare ground treatment, but the differences did not translate into higher yields (Table 3). Indirect measurement of leaf chlorophyll content using SPAD meter did not reveal differences (Table 2). Also, measurement of plant size by calculating plant area did not show any significant difference (Table 2).

There were significant differences between treatments for total number of leaves per plant. Plants on black plastic or Greenshift plastic mulch had a significantly higher number of leaves than the bare ground treatment. There was no difference in leaf numbers between the black plastic and

Greenshift mulch treatments (Table 4). Leaf area and dry weight/plant basis did not show any statistically significant differences.

Lettuce plants grew well in spite of fluctuating temperatures in October. The Greenshift plastic used in this study was distinct over the conventional black plastic and maintained higher soil temperature at 4-in. depth (Figure 4). Greenshift plastic was clearer and allowed more light to get in and heated the soil more. The bare ground treatments had the lowest soil temperature throughout the growing season.

Conclusions

Greenshift plastic used in this study is new and shows promise as a sustainable option for plastic mulch in vegetable production. Greenshift plastic mulch maintained higher soil temperatures, which is important in colder climate conditions like Iowa. With increasing grower interest in extending growing season, use of this plastic mulch in fall or spring could help warm the soil early and extend the growing season. We observed more weed pressure under Greenshift plastic but it was not a serious concern because low fall temperatures suppressed weed growth considerably. Use of Greenshift plastic mulch for production of summer vegetables such as tomato, pepper, or cucumber could produce

some challenges if weeds underneath the plastic are not controlled efficiently.

Figures 5–7 illustrate lettuce at the time of harvest in treatments tested. There was no statistically significant difference in plant yield or quality attributes between black or Greenshift plastic mulch. One of the primary objectives of this study was to evaluate whether Greenshift plastic could perform similar to black plastic mulch, which is an industry standard. This study highlighted positive effects of Greenshift plastic mulch but also showcased areas where this plastic needs to be modified to reduce weed growth, especially if used in summer vegetable production.

An additional test being conducted on Greenshift plastic is the cold endurance test. After lettuce harvest, plastic mulches were not removed and have been left in the soil to test their endurance and strength to withstand Iowa winter.

Acknowledgements

We would like to thank and acknowledge Greenshift Corporation and Hubert Farrish for their support on this project.

Table 1. Light intensity reflected from each of the treatments collected three times during the season.^{1,2}

Treatment	Date		
	10/30/2012	11/6/2012	11/09/2012
Bare ground	133 b	6 c	134 b
Greenshift plastic	90 c	7 b	89 c
Black plastic	248 a	17 a	212 a

¹Light sensor was placed 3 in. above and pointed towards the plastic or the bare ground treatment. Means are average of three readings/treatment per replication.

²Means within the same column followed by the same letter are not statistically different ($P \leq 0.05$).

Table 2. Lettuce leaf chlorophyll content and plant area four weeks after transplanting.

Treatment	SPAD ^{1,3}	Plant area ^{2,3} (square cm)
Bare ground	34.6	1078
Greenshift plastic	34.5	1038
Black plastic	33.4	1021

¹Means are average of readings from eight plants per treatment per replication.

²Means are average of values from eight plants per treatment per replication ($\text{Area} = \pi r^2$).

³No statistically significant difference between means within columns ($P \leq 0.05$).

Table 3. Marketable and non-marketable number and weight of lettuce plants.

Treatment	Marketable		Non-marketable	
	Number ¹	Weight ¹ (g)	Number ¹	Weight ¹ (g)
Bare ground	11	895	13	645
Greenshift plastic	12	990	12	595
Black plastic	13	1205	10	415

¹No statistically significant differences between means within columns ($P \leq 0.05$).

Table 4. Number of leaves, leaf area, and leaf dry weight of lettuce plants on a per plant basis at the time of harvest².

Treatment	Number ¹	Leaf area ³ (sq cm)	Plant dry weight ³ (g)
Bare ground	9 b	491	7.1
Greenshift plastic	13 a	442	8.0
Black plastic	10 a	495	7.2

¹Means within the same column followed by the same letter are not statistically different ($P \leq 0.05$).

²Means are average values from two plants per treatment per replication.

³No statistically significant difference between means within columns ($P \leq 0.05$).

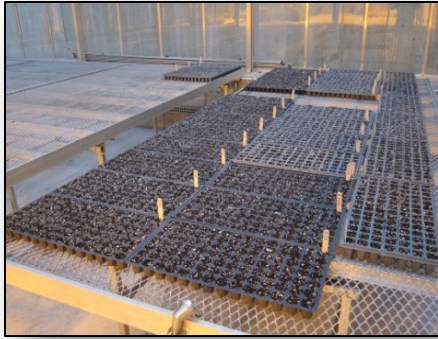


Figure 1. Flats seeded with lettuce in the greenhouse.



Figure 2. Watering of lettuce transplanted on September 13, 2012.



Figure 3. Laying of Greenshift plastic mulch using plastic mulch layer.

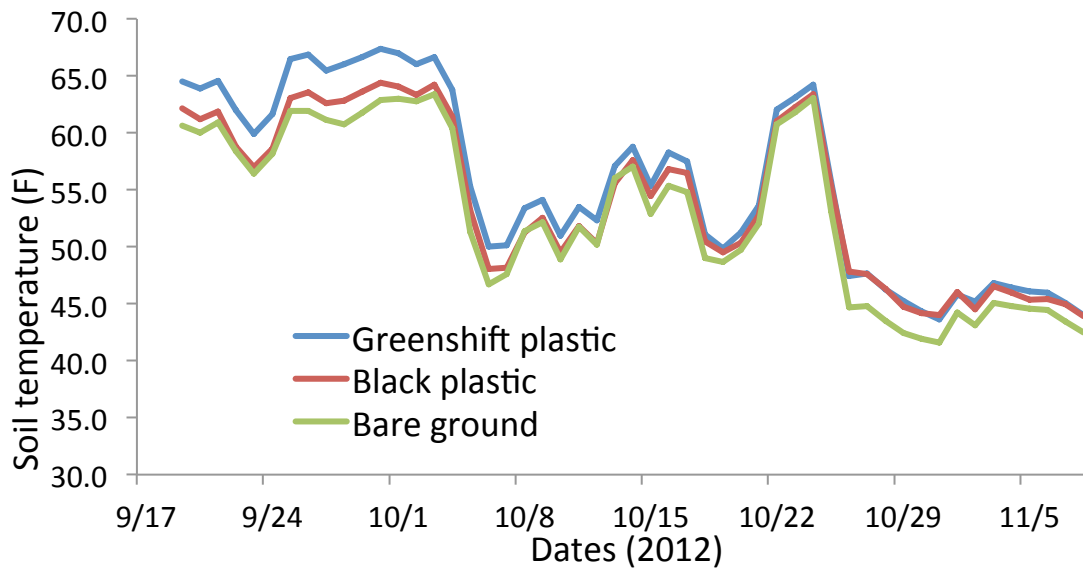


Figure 4. Soil temperature at 4-in. soil depth near actively growing lettuce plants.



Figure 5. Lettuce in bare ground treatment at the time of harvest.



Figure 6. Lettuce in black plastic treatment at the time of harvest.



Figure 7. Lettuce in Greenshift plastic mulch treatment at the time of harvest.