



## Mulching Comparison for Watermelon & Sweet Potato Production

### Staff Contact:

**Liz Kolbe** – (515) 232-5661  
[liz@practicalfarmers.org](mailto:liz@practicalfarmers.org)

### Cooperators:

- **Andy and Melissa Dunham** – Grinnell
- **Mark Quee** – West Branch
- **Jordan Scheibel** – Grinnell

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### In a Nutshell

- Fruit and vegetable farmers use mulch to control weed competition plus increase moisture retention for cash crops.
- Many fruit and vegetable farmers use plastic mulch but concerns about its environmental sustainability have farmers wanting to test other mulch types.

### Key Findings

- In 2012, both mulches reduced weeds compared to bare ground and the plastic mulch resulted in greatest sweet potato yields.
- In 2013, watermelon production was similar in the paper mulch and control plots.
- In 2014, sweet potato production trended higher in the plastic mulch although not statistically greater. The paper mulch and control were similar again but the paper mulch was shredded due to extreme weather leaving little mulch.

#### Project Timeline:

July 2012 – September 2012  
June 2013 to September 2013  
May 2014 – September 2014

### Background

Weed control is a primary concern in vegetable production; it is labor intensive and time consuming. Mulches are often used to suppress weed growth and to prevent soil erosion and conserve soil moisture. While plastic mulch has been a standard mulch option for many farmers, annual disposal of the plastic is wasteful (Silvernail et al., 2006; Ingman et al.,



*Watermelon and sweet potato were planted in three treatments: paper, plastic, and bare soil. Fruit size and number and labor were recorded throughout the growing season.*

2012). The purpose of this study was to investigate an effective and affordable alternative to plastic mulch appropriate for sweet potato production. Cooperators kept records of weed count, crop yield, and labor involved for different types of mulch application and the control plot (bare soil).

### Method

Andy and Melissa Dunham own and operate Grinnell Heritage Farm near Grinnell, Iowa. They grow USDA-certified organic vegetables, flowers and herbs on their 80 acre farm which has been in the family for over 150 years. They also tend a small herd of beef cows raised on pasture. They market their produce through a CSA (Community Supported Agriculture), Iowa City Farmers Market, and through select grocery stores.

Scattergood Friends School, managed by

Mark Quee, is a small Quaker boarding school in West Branch, with approximately 10 acres of IDALS-certified organic gardens and orchards and about 30 acres of pastures for grass-finished beef and lamb. Scattergood also raises a few heritage breed Guinea hogs, a small flock of turkeys, occasional broiler flocks, and a laying flock of about 100 chickens. Scattergood primarily grows food for their school, but occasionally sells to outside markets.

Middle Way Farm is a commercial market garden located at the Grin City Collective artist residency north of Grinnell and run by Jordan Scheibel. Started in 2013, the farm will include 2 acres of production in 2015 and is in the midst of a 3 year transition to certified organic production, with certification anticipated in 2016. Middle Way Farm produces chemical free

vegetables, fruits, flowers, herbs, and plant starts and markets primarily through a Community Supported Agriculture share, the Grinnell Farmers Market, and the Grinnell Local Food Source, an online buying club connecting customers and local producers that Jordan also co-owns and operates.

Cooperators tested bare soil (control), common black plastic mulch, and paper mulch (WeedGuardPlus®) in sweet potato and watermelon production (**Table 1**). We did not test biodegradable mulch because it is still in the process of being approved for organic use in the United States (it has been approved in Europe and Canada), and our cooperators' farms are certified organic or in transition.

### Sweet potatoes

In 2012, the Dunhams planted the variety 'Beauregard' at Grinnell Heritage Farm, and Mark Quee planted the varieties 'Beauregard' and 'Georgia Jet' at Scattergood Friends School. Plots were 3 ft wide and 40 ft long at Grinnell Heritage Farm. Plots were 3 ft wide and 100 ft long for 'Beauregard' and 60 ft long for 'Georgia Jet' at Scattergood Friends School. Each plot was treated with different mulch options or was left bare as the control. Treatments were replicated four times at each farm. There was 3 to 4 ft spacing between the plots.

Mulches were laid manually on May 18 and May 23, 2012 at Grinnell Heritage Farm and Scattergood Friends School, respectively. After laying the mulches, holes were manually punched to transplant sweet potatoes by hand. The time required to apply different types of mulch was also recorded. Sweet potato seedlings were transplanted on May 21 and May 30 at Grinnell Heritage Farm and Scattergood Friends School, respectively. Sweet potato seedlings were planted with 12-in. spacing between plants at both locations. At Grinnell Heritage Farm, Andy Dunham took a weed count once during the season by from four randomly selected 1-ft<sup>2</sup> areas within each treatment.

At Scattergood Friends School, Mark Quee did not take weed counts but recorded the hours spent weeding. He also kept observation notes. Cooperators harvested sweet potatoes when they reached peak maturity, and took measurements for marketable yield and the number of marketable versus cull tubers. At Scattergood Friends School, no buffer rows were planted because they did not have enough slips. Therefore, Mark Quee and his students collected data from all of the rows. They dug eight crowns from each plot and weighed them individually. Then they used a potato plow on the tractor to retrieve the rest of the sweet potatoes.

In 2014, Jordan Scheibel grew 'Beauregard' at Middle Way Farm in 4 ft x 20 ft plots. Three randomized replications of each mulch treatment were established. There was a three-foot spacing between plots.

Both paper and plastic mulches were laid with a tractor-pulled mulch layer on June 10, 2014. After laying the mulches, holes were manually punched to transplant sweet potatoes by hand. Within a day after application the paper mulch was shredded due to heavy rain and wind resulting in a true plastic mulch treatment compared to two bare soil treatments. Sweet potato seedlings were transplanted on June 14, 2014 at 24-in. plant spacing. Seven sweet potato plants were planted in each plot.

**Table 1**

**Descriptions of mulch products used in this study at Grinnell Heritage Farm in 2012, Scattergood Friends School in 2012 and 2013, and Middle Way Farm in 2014.**

Product	Description
Black plastic	Black polyethylene plastic film
Plastic	Dark brown colored paper mulch. 100% biodegradable. Allows water, air and nutrients to permeate.

Sweet potatoes were harvested on September 18 and 19, 2014 when they had reached peak maturity. Total yield per treatment, and total number of marketable tubers, jumbo tubers (classified as greater than two lb), small tubers and cull tubers were counted.

### Watermelons

In 2013, Mark Quee grew the watermelon varieties 'Sunshine' and 'Crimson Sweet' in 28 ft x 4 ft plots. Each plot was treated with different mulch options or was left bare as the control. Mulch treatments were replicated three times. There was six-inch spacing between the plots.

Both paper and plastic mulches were laid with a tractor-pulled mulch layer on June 11, 2013. The time required to apply different types of mulch was also recorded. After laying the mulches, holes were manually punched to transplant watermelons by hand. Because of weather challenges that year, transplants were planted later than ideal. Watermelon seedlings were transplanted on June 29, 2013 at 24-in. plant spacing. Mark Quee did not take weed counts but recorded the hours spent weeding and also kept observation notes. Watermelons were harvested when they reached peak maturity, and marketable yield and the number of marketable fruits for both varieties was measured three times on August 28, September 4 and September 14, 2013.

All data was analyzed using JMP Pro 10 (SAS Institute, Inc., Cary, NC) and comparisons among measured variables employ least squares means for accuracy. Each location was analyzed separately. At Scattergood Friends Farm in 2013, watermelon varieties were analyzed independently of one another. At that same location, a repeated measures approach was used to examine the effects of harvest date, mulch treatment, and their interaction on watermelon variables. Significance is reported at the  $P \leq 0.05$  level with tendencies noted at the  $0.05 < P \leq 0.10$  level and means separations are reported using Tukey's Least Significant Difference (LSD).



## Results and Discussion

### Labor Hours Associated With Mulch and Weeding

At Grinnell Heritage Farm in 2012, the plastic mulch treatment required the fewest hours overall (1.3 h), followed by the paper

**Table 2** Sweet potato ('Beauregard') yield as affected by mulch at Grinnell Heritage Farm in 2012.

Mulch	Marketable Tubers (no./plot)	Marketable Tubers (lb/plot)	Cull Tubers (no./plot)	Cull Tubers (lb/plot)	Weed Count (no./ft <sup>2</sup> )
No mulch	41.8	38.5 b	0.5 b	0.5 c	89.9 a
Paper	39.8	38.3 b	1.5 ab	2.3 b	7.3 b
Plastic	41.5	42.3 a	2.0 a	3.8 a	7.5 b

Within a column, values followed by the same lower-case letter are not significantly different ( $P \leq 0.05$ ).

mulch treatment (1.7 h) and bare ground (1.8 h). While bare ground did not require installation or set-up time, more time was spent weeding.

At Scattergood Friends School in 2012 and 2013, Mark Quee reported that laying the paper mulch and plastic mulch required about the same time, each taking 30 minutes. Mark found that both mulches were pretty easy to apply. He tilled an extra fine bed, primarily for the paper as it cannot mold itself around large clods of soil. The fine bed also made laying the plastic easier. For the paper mulch he geared the tractor down as much as possible and did not look back, trying to drive a straight as possible. With his experience with paper mulch for sweet potatoes in 2012, he feels he can now lay the paper essentially as fast as the plastic. There were no tears in the trial in 2013, though he did lose a large chunk of paper mulch in a wind storm further down the row out of the trial. Outside of the trial area, he again had to go back and manually bury more plastic than paper. Beyond that, few differences in labor were noted. Very little time was required for weeding the mulched treatments (about the same amount of time

**Table 4** Sweet potato ('Beauregard') total tuber count, marketable tubers and total tuber weight per plot at Middle Way Farm in 2014.

Mulch	Tuber count (no./plot)	Marketable tubers (no./plot)	Avg. tuber weight (lb/plot)
No mulch	100.0 a	57.0 a	77.1 a
Plastic	110.0 a	56.3 a	96.0 a
Paper	85.0 a	45.5 a	77.7 a

Within a column, values followed by the same lower-case letter are not significantly different ( $P \leq 0.05$ ).

for each) but more time was required for the control treatment; harvest times did not differ.

### Weed Count

At Grinnell Heritage Farm in 2012, there was an effect by the mulch treatments on weed counts ( $P < 0.0001$ ). Bare ground had the most weeds (89.9/ft<sup>2</sup>), while the two mulches controlled weeds similarly (7.4/ft<sup>2</sup>).

At Scattergood Friends School, both mulch treatments equally suppressed weed growth for sweet potatoes in 2012 and watermelons in 2013. There were weeds present in the bare ground control, but fewer than normal due to the drought conditions in both years, according to Mark.

### Sweet Potato Yield

At Grinnell Heritage Farm in 2012, there was no effect by the mulch treatments on the number of marketable tubers ( $P = 0.8275$ ) but there was an effect on the total pounds of marketable sweet potatoes ( $P = 0.0020$ ), as shown in **Table 2**. The plastic mulch resulted in more marketable pounds than did the bare ground or paper mulch treatments, which did not differ.

At Scattergood Friends School in 2012, average crown weight for the 'Beauregard' sweet potatoes differed among mulch treatments ( $P = 0.0009$ ), as shown in **Table 3**. Total plot yield of sweet potatoes differed among treatments for 'Beauregard' sweet

**Table 3** Sweet potato ('Beauregard' and 'Georgia Jet') yield as affected by mulch at Scattergood Friends School in 2012.

Mulch	'Beauregard'		'Georgia Jet'	
	Average Crown Weight (lb/crown)	Total Yield (lb/plot)	Average Crown Weight (lb/crown)	Total Yield (lb/plot)
No mulch	5.4 c	368.2 b	3.3	186.6
Paper	6.5 b	327.7 b	5.4	284.8
Plastic	8.5 a	522.4 a	10.1	354.2

Within a column, values followed by the same lower-case letter are not significantly different ( $P \leq 0.05$ ). Because of limited replications within the 'Georgia Jet' variety, results were unable to be included in statistical analysis and are presented as observations only.

potatoes, being greatest for plastic, and not differing between bare ground and paper mulch ( $P = 0.0634$ ). Eight randomly-selected crowns (vines and all attached tubers) were weighed within each replicate of each treatment. A similar trend to the 'Beauregard' variety was noted in the 'Georgia Jet' crowns. Greatest yield was observed with the plastic mulch, but statistical difference cannot be determined. No data was available for cull tubers or pounds of cull from Scattergood.

At Middle Way Farm in 2014, mulch type did not affect sweet potato ('Beauregard') total tuber count ( $P = 0.4183$ ), marketable tubers ( $P = 0.4204$ ) nor total tuber weight ( $P = 0.2939$ ). Total tuber weight, or yield of the sweet potatoes, varied among the treatments even though they were not statistically different (**Table 4**). The plastic treatment yielded 96.0 lb of tubers. The paper mulch (77.7 lb) and control (71.7 lb) yielded similarly. Less tubers and the least amount of marketable tubers were present in the paper mulch. Total tuber counts were similar between the no mulch and plastic treatments as were the number of marketable



Table 5

**Effects of mulch treatments and harvest date on 'Sunshine' watermelons at Scattergood Friends School in 2013.**

Harvest Date	Fruit count (no./plot)			Plot fruit weight (lb/plot)			Average fruit weight (lb/fruit)		
	No mulch	Plastic mulch	Paper mulch	No mulch	Plastic mulch	Paper mulch	No mulch	Plastic mulch	Paper mulch
August 28	3.7 aA	3.0 aA	3.3 aA	29.3 aA	21.2 aA	27.1 aA	8.0 aA	6.7 aA	8.0 aA
September 4	3.7 aA	1.0 aA	2.0 aA	23.1 aA	8.7 aA	13.4 aA	4.4 aA	2.9 aA	4.5 aA
September 14	2.3 aA	3.7 aA	3.7 aA	16.5 aA	21.2 aA	18.6 aA	4.5 aA	5.7 aA	5.1 aA
Total	9.7 A	7.7 A	9.0 A	68.9 A	50.0 A	59.2 A	16.9 A	15.4 A	17.6 A

By column, values followed by the same lower-case letter are not significantly different.

By measured variable and row, values followed by the same UPPER-case letter are not significantly different.

Table 6

**Effects of mulch treatments and harvest date on 'Crimson Sweet' watermelons at Scattergood Friends School in 2013.**

Harvest Date	Fruit count (no./plot)			Plot fruit weight (lb/plot)			Average fruit weight (lb/fruit)		
	No mulch	Plastic mulch	Paper mulch	No mulch	Plastic mulch	Paper mulch	No mulch	Plastic mulch	Paper mulch
August 28	0.0 bA	0.0 bA	0.0 bA	8.7 bA	0.0 aA	0.0 bA	0.0 bA	0.0 cA	0.0 cA
September 4	3.7 aAB	1.7 aB	5.3 aA	54.6 aA	23.8 aB	58.9 aA	15.1 aA	14.0 aA	11.5 aA
September 14	2.3 abA	2.7 aA	1.3 bA	17.5 bA	19.7 aA	7.7 bA	9.8 abA	7.0 bA	5.4 bA
Total	6.0 AB	4.3 B	6.7 A	72.1 A	43.5 B	66.6 AB	24.8 A	21.0 A	16.7 A

By column, values followed by the same lower-case letter are not significantly different.

By measured variable and row, values followed by the same UPPER-case letter are not significantly different.

tubers.

For Jordan, paper mulch was basically a failure in 2014 due to heavy rainfall and high winds in early June. "The plastic mulch clearly seemed to be the champ based on overall sweet potato weight, size of tubers, cleaner tubers and easier harvest because tubers were clustered underneath the plant versus spread out in bare soil and paper mulch treatments."

#### Watermelon Yield

At Scattergood Friends School in 2013, the number of fruits per plot, fruit weight per plot and average weight per fruit for each harvest date for the 'Sunshine' variety is presented in **Table 5**. There was no effect of the mulch on any of the measured variables at any of the three harvest dates for this variety (upper-case letters in table). Furthermore, there was no effect of mulch on the aggregated, end-of-season totals for fruit count, fruit weight or average fruit weight. When considering each mulch treatment separately, fruit count, plot fruit weight and average fruit weight were not affected by harvest date (lower-case letters in columns in table). Put another way, these measured variables were the same at each harvest date through the season.

The number of fruits per plot, total fruit weight per plot and average weight per fruit for each harvest date for the watermelon variety 'Crimson Sweet' at Scattergood Friends School in 2013 is presented in **Table 6**. The mulch had an effect on fruits per plot and total fruit weight per plot on the September 4 harvest date only. The least amount of fruits per plot and fruit weight per plot resulted from the plastic mulch treatment on that date. Average weight per fruit was not affected by mulch at any of the harvest



dates. For each mulch treatment, the September 4 harvest date generally resulted in the greatest number of fruit per plot, fruit weight per plot and average weight per fruit compared to the other two harvest dates.

### Conclusions and Next Steps

In 2012, results from Grinnell Heritage Farm and Scattergood Friends School indicate that mulch in either a plastic or paper form results in fewer weeds during sweet potato growth, and the increased labor of laying the mulch may be balanced out by the reduced weeding labor. However, Mark Quee at Scattergood Friends School noted that the mulches tended to blow around, leaving the rows and sometimes damaging the plants. At both farms, the plastic mulch resulted in the greatest yields. At Grinnell Heritage Farm, however, it also resulted in more cull plants, though this may simply be due to greater production and not a greater percent of cull tubers. Paper mulch did not seem to improve yields in the same way that plastic mulch did, but did reduce weeds equally as well.

In 2013, results from Scattergood Friends School indicates that paper or plastic mulch generally did not seem to improve fruits per plot, total fruit weight per plot and average weight per fruit

for either watermelon variety. Mark Quee expressed that after this trial, he is tempted not to use any mulch in watermelon production. However, he also mentioned the importance to evaluate alternatives to black plastic. In addition, an unusually wet spring followed by drought conditions in the summer of 2013 might have impacted the results.

In 2014 at Middle Way Farm, Jordan Scheibel grew sweet potatoes and experienced limitations of the paper mulch and its ability to withstand severe weather events. Jordan says, "I will be moving production of a number of crops to exclusively or almost exclusively plasticulture: sweet potatoes, cucurbits, and tomato family next year. I may also experiment with onions on plastic, which is my most difficult crop to keep weeded and I have heard anecdotally from another young grower in northern Iowa that using plastic on onions has been great for them."

All cooperators want to continue experimenting with other mulch types. Once available for certified organic farms these cooperators want to compare the performance of the biodegradable (Bio-TELO) mulch to the plastic mulch.

### References

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### PFI Cooperators' Program

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