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Use of Plastic Mulch for Vegetable Production

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Plastic mulch was first used for vegetable production in the 1960s and more growers are using plastics each year because of the advantages they provide. They are used commercially for both vegetables and small fruit crops. Vegetable crops that are well suited to production with plastic mulch are typically high value row crops such as tomatoes, peppers, melons, squash, and cucumbers. Although other crops such as sweet corn, snap peas, and pumpkin may benefit from plastic mulch, the increased costs may not be justified.

Advantages

There are many benefits to using plastic mulch in vegetable production. Although its use does not guarantee each benefit, the following advantages are generally realized.

1) Season Extension. In Utah, crops grown on plastic mulch typically mature 2 to 3 weeks sooner than crops grown on bare soil. This occurs because soil temperature under mulch is increased when incoming solar radiation is absorbed or trapped by the plastic. Warmer soil temperatures allow for earlier planting dates and help speed up early plant growth. White or silver mulches are used in summer and they reflect heat, causing a reduction in soil temperature. This can be helpful in hot conditions where cooler soil is desired.

2) Moisture Retention. Perhaps one of the most significant benefits for Utah vegetable production is the reduction in water use. Since plastics are impervious to water, soil water will not evaporate, significantly reducing water loss. Drip irrigation is typically used with plastic mulch, which further increases water savings.

3) Weed and Pest Management. Weeds compete with vegetable crops for nutrients and water. Plastic mulch greatly reduces weed competition resulting in a healthier crop, decreased labor and lower herbicide use. Some weeds may grow through crop holes in the plastic. Weeds also act as alternate hosts for insect pests, thus fewer weeds can reduce insect pressure. Additionally, silver/reflective plastics have been shown to reduce certain insect pests.

4) Leaching Reduction. Nutrient leaching is greatly reduced since applied water is better managed with plastic mulch. This can save on fertilizer costs and reduce the risk of groundwater contamination.

5) Compaction. The soil under plastic mulch is protected from foot traffic and rainfall. This helps keep the soil loose, friable, and well-aerated. Plants growing in non-compacted soils have better root growth and, therefore, increased water and nutrient absorption.

6) Quality. Vegetable quality is often improved, primarily due to the plastic being a barrier between the soil and fruit. This results in a cleaner product, and reduces soil-borne diseases that may infect the plant.

Disadvantages

While plastic mulch use has distinct advantages, there are some disadvantages that should be considered. Using plastic mulch increases inputs to the overall production system, resulting in increased costs.

1) Specialized Equipment. While it is possible to install plastic mulch by hand, commercial vegetable producers use specialized equipment which saves time and is more labor efficient. Plastic layers can install mulch over a raised bed or on flat ground (Figure 1). Equipment price ranges from one thousand to several thousand dollars depending on size, number of beds covered, and add-ons. A tractor is also required to pull the equipment. Add-ons include bed presses, drip tape layer, fumigator, and fertilizer dispenser. Add-ons can be purchased separately, but combining them into one piece of equipment reduces the number of passes across the field.

Figure 1. Single-row plastic layer pulled by tractor.

2) Installation. Beyond the cost of the plastic itself, additional labor and field operations are required to install plastics.

3) Removal. At the end of the growing season, plastic must be removed and disposed of. Removal can be time-consuming and care should be taken to avoid leaving any sections of plastic in the field since most do not decompose. Remnants are persistent, unsightly, and often blow around the farm.

4) Disposal. Disposal of the mulch raises environmental concerns as large amounts of plastic enter the landfill system. Most landfills require payment for disposal. Recently, biodegradable plastics have become available that may mitigate this concern, but the most commonly used plastic mulches are polyethylene based plastics that do not break down. In some areas, agricultural plastic recycling is available.

Mulch Selection

1) Types. There are two basic types of plastic mulch to choose between: smooth plastic or embossed plastic. Embossed plastics have greater stretch and are less prone to wind fatigue and cracking. They do not expand and contract under fluctuating temperatures as much as smooth plastic, helping maintain better plastic to soil contact throughout the day.

2) Thickness. Plastic thickness ranges from 0.6 to 2.0 mils, with cost increasing as thickness increases. Thin plastics typically only last through one crop and are more prone to tearing. A 1 mil plastic is a good choice for most vegetable crops. Thicker plastics can feasibly be reused and are recommended if double-cropping is desired.

3) Colors. Three main colors are used today: black, clear, and white. Black plastic is the most widely used mulch color and is typically the least expensive. Clear and white plastics are chosen over black under certain conditions where their unique properties are desired. Beyond these three main colors there are various other plastic colors available such as red, yellow, blue, gray, and orange.

Research shows some different effects with each color. Green or brown infrared transmitting (IRT) plastic is yet another option. IRT plastic selectively allows only infrared light waves through the plastic; allowing significant soil warming without having any weed growth.

Plastic mulches affect the microclimate around the plant by modifying the absorptivity and reflectivity of the soil around the plant. Each color changes the microclimate differently. The table below details the effect of different plastics on soil temperature, radiation, and weed control.

Table 1. Comparison of the effect of different colors of plastic on light and weed control.

Plastic Color	Soil Temp. (2-4'' depth)	Light Reflectivity	Light Absorptivity	Light Transmission	Weed Suppression	Comments
Black	Increases (3 to 5 °F)	Low	High	Low	Excellent	Most common. Does well in temperate climates.
Clear	Increases (6 to 14 °F)	Low	Low	Very High	Poor	Best in cool regions and for fall crops.
White/ silver	Decreases (-2 to 0.7 °F)	High	Low	Low	Excellent	Reflection interferes with movement of aphids. Best for tropical climates.
Infrared Transmitting (IRT)	Increases (5 to 8 °F)	Low	High	High	Excellent	Selective light transmission. Transmits the sun's warming wavelengths (like clear), but not those that allow weeds to grow (like black).

(Angima 2009, Penn State Extension 2015, and Sanders 2001.)

Installation Considerations

Plastic mulch needs to be properly installed. If plastic is laid inappropriately, many of the benefits discussed earlier are lost.

1) Soil Preparation. Till soil to incorporate organic matter or plant residues, beds form best when soil is friable and clod-free. Grass or weed residue on the soil surface will make it difficult to lay plastic tightly on the bed. In order for a raised bed to hold its shape the soil must have the right moisture content. A field that is too wet during bed formation will form clods and compact. If the soil is too dry, raised beds will not hold together and the sides will crumble. Take a handful of soil, press it together in your hand. If the soil holds together without excess water coming out, it will bed up properly.

2) Fertilization. Some plastic mulch laying equipment will incorporate fertilizer while the bed is formed and plastic is installed. However, if your equipment does not do this, it is best to apply fertilizer during soil preparation, before laying the plastic mulch. After the mulch is installed water soluble fertilizer can be injected through a drip irrigation system.

3) Bed Shape and Width. Plastic mulch can be used with either flat or raised beds. The width of the bed depends on the crop, how many rows are on the bed, and the cost of plastic. Many vegetable crops, including tomatoes, squash and melons, are planted on 2 or 3 foot wide plastic beds. Double rows of some crops, like peppers and eggplant, are planted on 3 foot wide beds.

Figure 2. Irrigation header line with single drip tape run below white plastic and above the soil surface. Plastic is 24 inches wide.

4) Irrigation. If using drip tape to irrigate, install the tubing while the plastic is being laid. Drip tape can either be laid on top of the soil or buried below the surface. Be sure the drip emitter holes are facing upward to reduce clogging. Tape placement on the bed will vary depending on the row configuration. One center drip line works well for single-row crops (Figure 2). Two off-center rows may be needed when planting two rows on a bed or in very sandy soils.

5) Contact and Anchoring. Plastic must be stretched tight and firmly secured at the edge, making good contact with the soil. Soil warming occurs through conduction so contact between the soil and plastic is critical for optimal heating. A loose plastic can seriously damage young transplants. Since the surface of black plastic can reach 130°F on a sunny day, leaf or stem burning

occurs when plants touch the plastic. The plastic layer should stretch the plastic and securely cover the sides of the plastic with soil. Generally, 6 inches of plastic on each edge is covered with the soil. Additionally, when air pockets occur between the soil and the plastic the air heats up significantly. This warm air can move to the crop holes, and desiccate tender young transplants.

6) Windbreaks. Strong winds can damage or tear plastic mulch. Windbreaks can be helpful in wind-prone areas (Figure 3). Trees or shrubs along the windward side can also protect a field from damage.

Figure 3. Grain strips and row covers over plastic. Grain strips act as windbreak.

Planting Considerations

1) Mechanical. For large commercial operations, mechanical transplanters are used to set plants through plastic. One of the simplest and most common transplanters is a water-wheel planter (Figure 4). It punches a hole in the mulch and fills the hole with water, while workers on the sides of the equipment set plants into each hole. Fully-automated transplanters are also available. When direct seeding, a similar planter is used that punches a hole and delivers the seed or a mix of potting soil and seed(s). All planters can be adjusted to various spacings and are pulled behind a tractor.

2) Hand. While more time consuming, hand transplanting is effective and commonly used on smaller operations. When creating holes for planting, it is better to make circular holes instead of cutting slits or an 'X' in the plastic. With holes there is less contact between the transplant and the hot plastic. A hole can be made by using a long-handed bulb setter, a sturdy can, or any other cylinder-shaped object. The hole should be 2 to 3 inches wide.

3) Transplants vs. Seed. Growers often use transplants or plant seeds through the plastic. There are pros and cons to both options. Transplants have a head start over direct seeding since you start with a larger plant, allowing for earlier harvest and possibly premium prices in early markets. Transplants are more uniform, which is beneficial during harvest and for timing pesticide applications. However, transplants are more expensive and require special care at planting. Direct seeding is usually less expensive than transplanting. However, growers typically over-seed, planning for some seeds to be unsuccessful. Thinning may be necessary and there may be stand issues if field conditions are not optimal. With rising seed costs, particularly for high-value crops such as seedless watermelon, using transplants may be justified.

Figure 4. Transplanter wheel.

Potential to Double Crop

The use of plastic mulch increases production costs by $500 to $1,000 per acre over bare ground production, not including drip irrigation costs. In order to get the most out of the additional inputs, some growers attempt to maximize the system by planting a second crop (double cropping). The success of double cropping depends on the crops planted, market demands, and length of the growing season.

Double cropping in Utah typically means planting a short-season crop early in the year and removing it immediately after harvest to make room for planting a second crop. The first crop should be harvested by early July to allow time for the second crop to mature before fall freezes. Ideally, choose crops that have short maturation times, are unrelated to reduce pest problems, and practice good crop rotation. Additional holes will need to be made in the plastic since plant spacing often varies between crops.
A second way to double crop is to use the plastic for 2 years in a row. Use a heavier plastic if trying this method. There are several problems with this approach including durability over the winter, deer/other animals puncturing holes through the plastic, and rodents living under the plastic and chewing holes in drip tape. Typically, the best combination of crops for this method is a high value, high input crop in the first year and a lower value crop in the second.

Conclusion

- Consider advantages such as season extension, water savings, and weed control over the increased costs of using plastic mulch.
- Determine if additional equipment will be needed for your operation.
- Choose from the various types, thicknesses, and colors of mulch available.
- Take particular care to prepare fields and install plastic correctly to fully realize benefits.
- Decide on planting method and choose between transplants and direct seeding.

Sources for Plastic

Depending on your location, finding a local source for plastic mulch is problematic. Some garden centers may carry it, but often length and colors available are limited. Ordering from an online supplier affords greater diversity. Keep in mind that shipping costs can be high as plastic is quite heavy. The supplier list below is not all inclusive, and is not meant to specifically endorse or discriminate against any one vendor. Order plastic well in advance of when you need it to ensure you get what works best for your operation.

Plastic Sources

- Robert Marvel http://www.robertmarvel.com/Plastic_Mulch.html
- MulchFilm.com http://mulchfilm.com/MulchFilm/__Home__.html
- Agriculture Solutions http://www.agriculturesolutions.com/products
- Zimmerman http://www.zimmermanfarmservice.com/
- Reddick http://www.reddickfumigants.net/Products/Plastics%20&%20Drip/Plastics.htm
- Harris Seed https://www.harrisseeds.com/storefront/s-272-mulches-plastic-paper.aspx
- Grower's Solution http://www.growerssolution.com/page/GS/CTGY/mulch

Equipment Sources

- Nolt's Produce Supplies http://www.noltsproducesupplies.net/
- Kennco Manufacturing http://www.kenncomfg.com/products/plastic-mulch-layer
- Rainflo Irrigation http://www.rainfloirrigation.com
- Mechanical Transplanter http://www.mechanicaltransplanter.com/layer.html
- Market Farm http://www.marketfarm.com/cfms/mulch_layers.cfm

Additional Readings

Angima, S. 2009. Season extension using mulches. Oregon State University Extension: Small Farms. Vol. IV No. 3 http://smallfarms.oregonstate.edu/sfn/f09SeasonMulches

Ngouajio, M. 2011. Managing plastic mulches profitably. Michigan State University Extension. http://msue.anr.msu.edu/news/managing_plastic_mulches_profitably

Orzolek, M.D. and W. J. Lamont, Jr. 2015. Summary and recommendation for the use of mulch color in vegetable production. Penn State Extension.

http://extension.psu.edu/plants/plasticulture/technologies/plastic-mulches/summary-and-recommendations-for-the-use-of-mulch-color-in-vegetable-production

Penn State Extension. 2015. Plastic mulches. Penn State Extension, College of Agricultural Sciences. http://extension.psu.edu/plants/plasticulture/technologies/plastic-mulches

Sanders, D. 2001. Using plastic mulches and Drip irrigation for home vegetable gardens. Horticulture information leaflet. North Carolina Extension Resources. http://content.ces.ncsu.edu/using-plastic-mulches-and-drip-irrigation-for-vegetable-gardens/

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