Commercial Vegetable Production With Plastic Mulches

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In New Mexico, growing vegetables commercially, whether for vegetable sheds or farmers' markets, requires intensive management and marketing skills. Success involves properly managing scarce water supplies, controlling weeds and other pests and supplying a high-quality product when the price is high. High prices generally are associated with limited supply and high demand.

Mulches

Mulching is an agricultural cropping technique that involves placing organic or synthetic materials on the soil around plants to provide a more favorable environment for growth and production. Organic mulches traditionally are used in backyard gardens and smaller truck gardening operations, since materials may be limited and application techniques are labor intensive. Organic mulches provide many of the benefits of most synthetic mulches, except soil warming and perennial weed control. Unlike synthetic mulches, however, organic mulches like hay, straw, grass clippings, and compost tend to return nutrients to the soil through decomposition.

Inorganic plastic mulches have been used by commercial growers since the early 1960s, with black and clear plastics being the most popular. Tomatoes, peppers, eggplants, vine crops and okra generally respond well to these plastics. Plastic mulches normally are used in conjunction with drip irrigation to maintain optimum soil moisture and for improved stand establishment.

Advantages of Plastic Mulch (Lamont, 1991)

- **Earliness and greater yields.** Earlier plant growth and earlier crop production are two of the primary benefits of using black and clear plastic mulches. Earlier crop production generally results in higher market prices and higher yields. Black plastic mulch can accelerate crop production as much as one to two weeks. Clear plastic mulch has been shown to increase earliness as much as three weeks in northern climates. Weed growth, however, can be a major problem under clear plastic unless appropriate herbicides or fumigants are used. Selecting the crop type (vine crops like pumpkins, squash, melons) also is important in warmer areas of the state for good ground cover or shading in the summer to prevent excessive heat build up under the plastic.
- **Reduced evaporation.** Plastic mulches help reduce evaporation of moisture from the soil. Irrigation frequency and amounts generally can be reduced, although additional water may be needed to support earlier and greater crop production. A more uniform soil moisture also will result in less plant stress.
- **Weed control.** Since black plastic mulch prevents light from reaching the soil, growth of annual and most perennial weeds can be prevented. Thin black plastic mulch will not, however, control nutsedge.
- **Improved quality.** Plastic mulches help prevent fruit crops from touching the soil. This reduces the incidence of fruit rots and keeps fruit cleaner.
- **Reduced soil compaction and root pruning.** Better weed control results in less cultivation and less root pruning. Undisturbed beds also remain more friable with less compaction. Weeds between beds can be controlled with directed herbicides or by mechanical means.
- **Reduction in fertilizer losses.** Flood and furrow irrigation techniques tend to leach nitrogen and other water soluble nutrients below the root zone. Since plastic mulch techniques generally include drip irrigation, nutrient loss is kept to a minimum. Nutrients can be injected into the drip

system and accurately delivered to the root zone as needed.
- **Insect control.** In some cases, reflective silver and white plastic mulches help repel aphids and other insects that damage plants and are vectors of viral diseases.

Disadvantages of Plastic Mulch

- **Removal and disposal.** Removing the plastic mulch after the cropping season is the biggest disadvantage. Although removal equipment is available, plastic tends to become brittle in New Mexico's intense sunlight, making it difficult to remove in one piece. The "tucks," or sides of the mulch buried in the dirt, remain intact, since they are not exposed to the sunlight and separate from the brittle mulch on the bed top. Little pieces of plastic can scatter across a field. Many landfills also will not accept plastic, and it is difficult to recycle. Photodegradable and biodegradable mulches have been evaluated, but results have been mixed. Another alternative is woven, black polypropylene mulch with an ultraviolet light inhibitor that can be reused for many seasons.
- **Cost.** The cost of applying plastic mulch can be quite high both in terms of materials and equipment. The minimum equipment required includes bed-shaping equipment and a mulch applicator. Other equipment may include a drip-line applicator (usually associated with the mulch application) and a transplanter or seed planter. The advantages of using a mulch for earliness, increased yields, reduced water application, better weed control and higher prices must offset the increased cost of using plastic mulches.
- **Management.** With drip irrigation, managing plastic mulch is more intense. Wilting plants could mean a plugged drip line, while overly wet areas could mean rodent damage to the lines. Drip line problems are hard to evaluate when covered with mulch.

Types of Plastic Mulch

Most commercial plastic mulches are made of either linear, low-density polyethylene or high-density polyethylene. High-density polyethylene is lighter and stronger than the same thickness of low-density polyethylene. Most plastic mulches vary in thickness from 0.75 to 1.5 mil and may be smooth or embossed (McCraw and Motes, 1991). The diamond-shaped pattern on embossed plastics helps reduce contraction and expansion of the mulch. Also, it generally is more resistant to wind fatigue and cracking. Plastics come in rolls 2,000 to 4,800 feet long (depending on the thickness) and are 3 to 5 feet wide.

Woven, black polypropylene mulches have been used in the greenhouse and nursery industries for some time as weed barriers. These ultraviolet, light-stabilized mulches are guaranteed to last up to five years. They allow water and air penetration while controlling weeds. These tear-resistant mulches (16 mil thick) can be reused year after year. In experiments with small vegetable producers in northern New Mexico, these mulches have been used to warm the soil, control weeds, harvest rainfall and reduce evaporation of moisture from the soil.

Mulch Colors

A mulch's color affects the temperatures below and above the mulch through the absorption, transmission and reflection of solar energy. This affects the microenvironment surrounding the plants. The degree of contact (thermal contact resistance) between the mulch and the soil also affects soil warming. The better contact the mulch has with the soil, the more effective the warming properties of the mulch (Lamont, 1999).

- **Black.** Black plastic mulch is the most popular color used in commercial vegetable production, especially for weed control. As a blackbody absorber, this plastic absorbs most incident solar radiation, including visible, infrared and ultraviolet light. Much of the thermal energy, however, is lost to the atmosphere through convection and reradiation. Transferring of thermal energy to the soil can be optimized by maximizing mulch contact with the soil. Soil temperatures under black plastic during the daytime can be as much as 5ºF higher at a 2-inch depth and 3ºF higher at a 4-inch depth than bare soil at the same depths (Lamont, 1999).
- **Clear.** Soil temperatures during the daytime under clear plastic can reach 8-14ºF higher at the 2-inch depth and 6-14ºF higher at the 4-inch depth than bare soil at the same depths due to a greater (85 to 95%) solar radiation transmittance. Clear plastic absorbs very little solar radiation. Water droplets that condense on the underside of clear plastic allow solar light (short-wave radiation) in, but block outgoing, long-wave infrared radiation (heat). This heat normally is lost to the atmosphere from bare soil. Incoming solar radiation, however, makes weeds a major problem under clear plastic unless controlled with a herbicide or fumigant

(Lamont, 1999). Solarizing or disinfecting of the soil has been used in some areas of the country to reduce soilborne diseases and some weeds. To achieve sufficiently high temperatures for solarization, the soil must remain covered for several weeks during the hot part of the summer. Good soil moisture will improve thermal conduction of heat into the soil profile (Katan, 1980).

- **White.** Light is reflected back into the atmosphere or the plant canopy from a white plastic mulch, resulting in slightly cooler (-2ºF at 1-inch depth) soil temperatures. White plastic mulches can be used to establish crops in the summer, when a reduced soil temperature might be beneficial. Coextruded white on black plastic mulch helps cool the soil (white) while controlling weeds (black) (Lamont, 1999). The light reflected back into the plant canopy with white mulches also can be helpful for some greenhouse crops that have limited light.
- **Silver/aluminum.** Reflective silver or aluminum mulches also give cooler soil temperatures. They tend to repel aphids, which can serve as vectors for various viral diseases (Lamont, Sorensen and Averre, 1990).
- **Red.** Red plastic mulch has been shown to increase tomato yields and quality in some trials and reduce the severity of early blight in others. It also has been shown to increase yields of honeydews, muskmelons and zucchini. In addition, it has been shown to significantly increase soil temperatures (Lamont, 1999). Not all red colors are the same, however, and results have not been consistent.
- **Other colors.** Yellow, orange, blue and gray plastic mulches also have been evaluated. The different radiation patterns that are reflected back into the canopies of various crops from these mulches affect plant growth and development in different ways. Some colors like yellow attract certain insects like green pea aphids and cucumber beetles (Lamont, 1999). Such mulches might be used in a field to grow "catch crops" to pull insects away from other crops. Blue-colored mulches have been shown to increase zucchini and honeydew yields. More research needs to be conducted to determine the effects of these colors on plant growth, yields, earliness and pest resistance.
- **Wavelength-selective mulches.** These mulches selectively absorb photosynthetically active radiation (PAR), while transmitting solar infrared radiation. Also called infrared-transmitting (IRT) mulches, they help control weeds and exhibit improved soil-warming characteristics, although generally not as well as clear plastic. Colors range from blue-green to brown (Lamont, 1999).

Soil Preparation and Preplant Fertilization

The soil should be deep plowed or disked at least one month before bed preparation. Incorporate crop residues well. Remove all trash, rocks or clods from the field that may hinder the application of the plastic. Preplant fertilizers can be broadcast and incorporated into the beds as they are formed. Good soil moisture (60 to 80% of field capacity) is necessary to make firm, smooth beds (Granberry, Kelley, Chance, McLaurin, Harrison, Sanders, 1994). It is important that the bed be firm, so the soil doesn't settle.

Plastic Mulch and Drip Irrigation Line Application

Plastic mulchs can be applied by hand in smaller operations or by machine in larger ones. The basic technique involves bedding up the soil, shaping and pressing the bed and applying the plastic mulch and drip irrigation line. These operations can be performed separately or in various combinations.

First, beds are raised with hilling discs and then compressed to a uniform height and density with a bed shaper. Beds normally have 5- to 6-foot centers and generally are 4 to 6 inches high and 30 to 34 inches wide, sloping slightly (1.25 inches) from the center to the edges to shed excess rainfall (Lamont, 1991).

Mulch applicators generally include a mulch dispenser that holds at least one roll of plastic, small discs at the bed edges to clean out or open the furrows, rubber inflatable tires that press the edges of the mulch into the furrows, and discs that cover the edges (tucks) of the mulch with soil to keep it in place. The plastic must be kept taut to ensure good contact with the soil. Drip line and fumigant applicators usually are located in front of the mulch applicator. Newer machines may combine bed formation and mulch application.

The drip line can be installed on the soil surface under the mulch or 2 to 3 inches below the soil surface. The emitters should face up to reduce plugging. For most crops like tomatoes, chile and vine crops planted one row per bed, the drip line should be located 4 to 8 inches to the side of the crop and 1 to 2 inches deep. The crop should be planted in the middle of the bed. Transplants or direct-seeded vegetables can be planted directly through the plastic with a machine or by hand. Starter fertilizer solutions generally are applied to transplants to promote early growth.

Fertilize plants midseason by injecting appropriate soluble fertilizers through the drip line.

Removal of Plastic

The plastic must be removed after the growing season. Do not disc plastic under. Machines are available commercially for plastic removal, but they can be expensive. In most cases, the plastic must be removed by hand and disposed of in a landfill.

Water Harvesting

Most impermeable plastic mulches are applied on a slight slope from the middle of the bed to the edge to shed rainfall and prevent flooding. This also keeps water from accumulating around melons or other vine crops and causing fruit rot and cracking, which is rarely a problem in the desert Southwest. Ideally, rainfall should be used to supplement irrigation water.

Woven, black polypropylene mulch has been used experimentally by NMSU's Cooperative Extension Service specialists to harvest rainfall to produce crops like tomatoes, chile, cantaloupes, pumpkins and squash, and to reduce the need for supplemental irrigation (Dickerson, 2000). One such technique involves securing a 4-foot wide piece of woven plastic across a level field with 6-inch fabric pins along the edges and then building borders on the edges to channel irrigation water down the plastic. The plastic helps reduce water evaporation from the soil and helps harvest rainfall, which seeps through the plastic preventing it from accumulating around fruit.

Direct-seeded or transplant crops are planted through holes burned through the middle of the plastic with a propane torch or round branding iron. Fabric pins placed through the plastic near the holes keep the plastic in place and prevent plant abrasions. The plastic not only helps to conserve and harvest moisture, but also to control bindweed and other weeds and warm the soil, resulting in earlier crops. An ultraviolet light inhibitor incorporated into the plastic makes it reusable, eliminating disposal problems associated with traditional plastic. Its higher cost can be depreciated over its longer life span.

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