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Plastic mulching: An innovative approach to check weed population

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INTRODUCTION

Mulching is the process or practice of covering the soil/ground to make more favorable conditions for plant growth, development and efficient crop production. Mulch technical term means 'covering of soil'. While natural mulches such as leaf, straw, dead leaves and compost have been used for centuries, during the last 60 years the advent of synthetic materials has altered the methods and benefits of mulching. The primary purpose for using mulches is for weed suppression in the crop to be grown. Mulches typically function by blocking light or creating environmental conditions which can prevent germination or suppress weed growth shortly after germination. However, numerous other benefits are often obtained including: increased earliness, moisture conservation, temperature regulation of the root zone and above-ground growing environment, reduced nutrient leaching, altered insect and disease pressures, and, in some instances, reduced soil compaction or improved soil organic matter (Lamont, 2005; Ngouajio and McGiffen, 2004). Black polyethylene and other opaque films effectively suppress a wider spectrum of agricultural weeds than most organic mulches. Easy mechanical application, cost efficient weed control, and increased crop yields have led to widespread adoption of plastic mulch by organic and conventional vegetable farmers.

Disadvantages of plastic film mulch include the costs of mulch removal at the end of the season (required under USDA Organic Certification), petroleum consumption, waste generation, and the fact that plastic mulches do not build soil organic matter. A newer generation of synthetic mulches includes weed barrier or landscape fabric that lasts multiple seasons, several biodegradable mulches, and variously colored opaque or translucent films developed for specific crops or purposes.

Basic properties of mulch film

a. Air proof so as not to permit any moisture vapor to escape
b. Thermal proof for preservation of temperature and prevention of evaporation
c. Durable at least for one crop season

Characteristics of plastic mulches

The most common mulches are 1.0 or 1.25 mil-thick and are sold on a 1.2 m-wide roll, though widths of 0.9 – 1.5 m are also produced. Mulches that are thinner than 1.0 mil are easily punctured by weeds. Most degradable plastic mulches are 0.5-0.75 mil-thick, which allows for quicker decomposition. Rolls of mulch commonly range from 730 – 1830 m in length. Mulches may be smooth or embossed. Mulches that are embossed tend to resist excessive expansion and contraction which can cause mulches to become loose from raised beds (Lamont, 1993).

Colored plastic mulches

The most popular plastic mulch world-wide is black, though white-on-black and clear mulches are also used (Schales, 1990). Other colors that that have been evaluated include: blue, green, red, yellow, brown, white, and silver. Different colored mulches have multiple effects on the crops being grown. Colored mulches can be separated into those that do not discriminate between different wavelengths of light transmitted and those that selectively prevent transmission of photosynthetically active radiation (PAR) (400-700 nm) (Ngouajio and Ernest, 2004; Tarara, 2000). Mulches that selectively filter out light in the PAR range are called infrared transmitting (IRT) mulches.

In addition to restricting light of the PAR range, IRT mulches tend to transmit high percentages of light at longer wavelengths (>900 nm). By selectively filtering light in the PAR range and transmitting longer wavelength light energy, IRT mulches allow for greater soil warming while reducing light available for weed growth.

Black Plastic Film

Black plastic film mulch, used in conjunction with in-row drip irrigation, is the weed management option of choice for many medium-to large-scale organic and conventional vegetable farms. Unlike clear mulches, black plastic absorbs nearly all shortwave radiation to heat the soil. By absorbing radiation, black-plastic mulch heats the soil through conduction. The opaque film reduces germination of light-responsive weed seeds; shades out and physically blocks the emergence of most weeds; and can enhance crop growth by conserving soil moisture, promoting soil warming, and speeding nutrient mineralization from soil organic matter. The crop growth benefits contribute to weed management by enhancing the crop's ability to tolerate and compete with weeds Warm season crops like tomato, pepper, eggplant, melon, sweet potato, and okra are often grown on raised beds mulched with black plastic, and this system is sometimes used for early plantings of onion, lettuce, brassicas, and other cool-season crops as well.

Black plastic mulch does not eliminate all weeds. Light reaching the soil surface through planting holes and in uncovered alleys between mulched beds allows weeds to emerge and establish; thus, additional measures are needed to manage weeds in these areas. Weeds in plant holes can compete severely with the crop if they are not removed early and vining species like morning glories (*Ipomoea* spp.) and bindweeds (*Convovulus arvensis* and *Calystegia sepium*) grow toward the light of planting holes and climb the crop plant. Nutsedges (*Cyperus*spp.) and a few other weeds with sharp growing points can puncture and emerge through the film. Black plastic can accelerate the growth and spread of purple nutsedge (*C. rotundus*) by warming the soil (Webster, 2005). Many growers apply straw, hay, or other organic mulch to the alleys and overlap it onto the plastic, either at the time of planting, or after one or more cultivations. The organic mulch suppresses alley weeds, conserves soil moisture, and provides organic matter that can later be incorporated into the soil.

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Clear, Translucent, and other Colored Plastic Films

Clear, translucent, and infrared-transmitting (IRT) plastic films that allow solar radiation to reach the soil will warm the soil more effectively than does black plastic. During very hot sunny weather, a tight fitting clear plastic film can heat the soil sufficiently to kill rhizomes and other vegetative weed propagules, some weed seeds, and most plant pathogens in the uppermost several inches of the soil profile. This process is called soil solarization, and is a valuable tool for preparing small areas for planting certain high-value crops. Vegetables are not normally planted into clear plastic, because the heat buildup under this mulch can damage the crop during hot weather, and accelerate weed growth during cooler conditions.

Translucent green, brown, olive, and IRT (infrared-transmitting) plastic films have been developed, which combine greater soil warming (compared to black plastic), with fair weed suppression. Because they absorb the red and blue light wavelengths used by all plants in photosynthesis, and transmit mostly infrared (heat) wavelengths and some green light, these materials reduce weed germination, emergence, and growth compared to clear film or bare soil. Translucent films do not control weeds as effectively as black plastic, and should be used on crops for which soil warming is critical, and in fields with light-to-moderate weed populations.

Film mulches with white or reflective surfaces lower soil temperature compared to uncovered soil. This can benefit crop growth and competitiveness against weeds during the hottest summer months, when soil temperature under black mulch would exceed the optimum range for the crop. For example, tomato prefers moderately warm (70–85 °F) root zone temperatures and can be stressed by higher temperatures (Tindall et al., 1990); thus, farmers in warm climates often use a white mulch for later tomato plantings, or apply whitewash to black mulch when hot weather sets in after the crop is planted.

Research has shown that the quality of light reflected by mulch can affect crop production (Orzolek and Lamont, 2000). Reflective (silver colored, aluminum-coated) films disorient and repel aphids, whiteflies, and some other pests. Red plastic has been reported to enhance tomato and strawberry yields by 12–20%, and dark blue plastic to improve cucurbit yields (Orzolek and Lamont, 2000). However, studies in Iowa showed no difference in tomato yield in red, IRT, and black mulches (Taber and Smith, 2000). Lack of consistency among research results suggests that the benefits of different colored mulches may vary with local conditions (climate, insect pest populations, etc.); thus, farmers may be well advised to test specialized colored mulches on a small scale before investing in application on a larger area.

Biodegradable Plastic Mulch?

For years, researchers have tried to develop degradable plastic mulches that would eliminate the need to gather and dispose of spent, dirty plastic at the end of the season, which can entail significant costs for medium-to-large scale operations. Many growers rejected the early versions of photodegradable and biodegradable mulches, which left fragments of undecomposed mulch in the soil and thereby created a litter problem. More recently, plant-starch-based biodegradable black plastic films have been developed. These perform as well as standard black polyethylene film, and appear to decompose completely (Rangarajan and Leonard, 2007; Ngouajio et al., 2008). However, as of the fall of 2011, the USDA National Organic Program (NOP) has not yet approved these products, which contain synthetic ingredients, residues of which could remain in the soil after the mulch has broken down.

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