Synthetic Mulches (Physical weed management)

Objectives: Students should know the ways in which synthetic mulches are used for weed control. Know which of these measures are applicable to organic weed management. Be familiar with examples of each.

The National Organic Program: Petroleum-based mulches and covers except for those made with polyvinylchloride (PVC) can also be used as long as they are removed from the field after harvest.

Used to manage weeds by decreasing photosynthetically active radiation, enhancing soil fumigation, and enabling soil solarization.

Benefits

- Weed growth inhibition
- Increased soil temperature leading to faster crop development and earlier harvests.
- Reduction in the rate of fumigant loss as a result of the water layer that is formed beneath the mulch
- Fruit protection from rain-splash and soil organisms.
- Good durability – permits double cropping.

Disadvantages

- Removal and disposal of polyethylene film from the field is costly and has become an environmental concern where landfill space is scarce. In 2004, the use rate was 130 million kg per year with disposal costs of about \$250 ha^{-1}
- Polyethylene mulch acts as a water-impermeable layer over up to 75% of a planted field, causing water and agrochemical runoff into nearby water systems and thereby increases environmental impacts on nearby watercourses and lakes.
- A study that compared the off-site translocation of soil and agrochemicals between tomato plots under polyethylene mulch and a residue mulch of hairy vetch (*Vicia villosa*) indicated significantly greater quantities of pesticide runoff with the polyethylene mulch.
- Opaque polyethylene film does not effectively suppress nutsedge unless a soil fumigant has been applied.
- Without soil fumigant grass and broadleaf weeds emerge through the planting holes.

Opaque mulch:

- Suppress weeds by restricting the availability of light for photosynthesis and thus weed growth and development.
- They are not effective against nutsedges, which in the absence of light growth by means of rhizome elongation from sprouted tubers. The tips of the rhizomes are very sharp and puncture opaque mulches. On emergence through the mulch, a light stimulus is detected and the growth pattern switches from rhizome elongation to leaf expansion.
- Black film is used in spring in Florida to promote soil warming.

- White-on-black coextruded film with the white side up is used in fall to moderate soil temperatures.
- Metalized (hybrid metalized polyethylene film) mulches such as chrome-on-black are also available that combine the advantages of weed suppression with the deterrence of insect pests due to the reflective surface. (Brite 'Nup, Adcock Manufacturing Corp., OMRI-listed).

Colored Mulches

- Some colored mulches eg red may not be opaque unless coextruded with black film. Usually, partially translucent allowing radiation to pass through and warm the soil, but also reflects radiation back into the plant canopy changing the ratio of R:FR light. Red mulch is thought to enhance fruit yield in some crops such as tomatoes. Yellow mulch is thought to attract insects (whitefly, cucumber beetle, some aphids) and can be used with trap crops to attract pests away from the main crop.

Transparent film:

- Used as a production mulch in cooler climates (California) for soil warming.
- Soil solarization in hot climates and in summer in subtropical and temperate climates.
- SS is the process of suppressing soilborne pests in moist soil using heat generated by solar radiation penetrating transparent polyethylene mulch.
- Duration of 6 to 8 weeks to control many annual weeds and to suppress perennial species such as purple and yellow nutsedges. Nutsedge rhizomes emerging from the soil under transparent film are stimulated by light to undergo leaf expansion under the mulch.
    - Trapped nutsedge plants under the film experience lethal temperatures and succumb to foliar scorching.
    - Tubers that occur at shallow depths that heat to 122 F (50 C) or higher are killed directly.

- Heat-retentive films result in higher soil temperatures and more hours of lethal temperatures than standard polyethylene firm for the same duration of soil solarization.
- Soil solarization is more effective when beds are oriented in a north-south direction.
- When just raised beds are solarized, additional means of managing weeds in the row middles will be needed.

Infrared transmitting (IRT) film:

- Like opaque mulches, IRT film suppresses grass and broadleaf weeds.
- Considerably more effective in suppressing nutsedges than opaque mulch.
    - IRT film transmits a small amount of light
    - enough to trigger nutsedge leaf expansion to occur beneath the mulch

    - but insufficient to allow the nutsedge shoots to thrive and develop, and produce daughter plants and tubers.
- Available in brown, green and olive – allows IR radiation to pass and warm up the soil during the day, but blocks photosynthetic wavelengths (PAR), preventing most weed growth.
    - Use Brown when you need to focus on better weed control
    - Green offers the highest marketable yields
    - Olive brings you the best of both worlds!

Conventional systems

Plasticulture: Vegetable production systems based on soil fumigation with broad spectrum biocides such as methyl bromide aimed primarily for nematode and pathogen control, but also effective in controlling weeds and soil borne arthropod pests.

In the past methyl bromide was used almost exclusively. Chloropicrin was included as a marker since MB is odorless (98:2 mixtures). 67:33 ratio sometimes used where soilborne diseases were a major problem. Chloropicrin is also an effective soil fumigant.

Only used in horticultural crops (high value crops and ornamentals)

- Important tools in high value vegetables
- tomatoes, bell peppers, eggplant and strawberry.
- Methyl bromide:chloropicrin (98:2 and 67:33) - fumigant of choice for many years.
- Effectiveness of MBC on weeds resulted in limited or no registered chemical alternatives.
- MB is contributing to stratospheric ozone depletion.
- MB phased out in 2005.
    - Now only available through a critical use exemption process. Smaller amounts available and more costly.
    - 50:50 ratios with more effective mulch formulations.
    - More effective mulches needed.
    - HDPE, metalized mulch, virtually impermeable film for greater containment and reduction of emissions.

Fumigant tarps

Applied soon after soil fumigation to reduce volatility and retain the chemicals in the soils to ensure adequate exposure of the pests.

Virtually impermeable film (impermeable layer sandwiched between layers of polyethylene film). In Hytibar - Ethylene-vinyl alcohol copolymer (EVOH)

- Reduce fumigant emissions
- Longer duration in soil
- More effective pest control
- Greater incidence of crop injury.

Alternatives to MBC are:

Methyl iodide
Telone (1,3-dichloropropene), often used in mixtures with chloropicrin.
Vapam (metham - sodium methyldithiocarbamate).
K-Pam (potassium methyldithiocarbamate).
Basamid (dazomet).
Telone products - weak on nutsedges.
Metham is applied to seedbeds to control weeds and soilborne plant pathogens.

Geotextiles or Landscape fabrics:

Allow penetration of water, nutrients and air but limit PAR.
Used in systems where the mulch is needed for long time – landscaping and perennial crops.

Willard and Valenti. 2008. HortTechnology 18:75-79

Woven landscape fabric most effectively eliminated weed emergence in a juneberry crop (*Amelanchier alnifolia*) (Fig. 1 and 2)

However, plant height and width was about 25% less than in the untreated control (which was handweeded monthly for 3 months).