



## **Mulching- A Soil and Water Conservation Technique for Smallholder's Olericulture Farming in Tropics and Sub-tropics**

**Anil Kumar Saxena<sup>1</sup> and Suneeta Singh<sup>2</sup>**

<sup>1</sup>Associate Professor, Department of Soil Science, School of Agricultural Sciences, SGRR University, Dehradun- 248 001, Uttarakhand

<sup>2</sup>Assistant Professor, Department of Horticulture, School of Agricultural Sciences, SGRR University, Dehradun- 248 001, Uttarakhand

### **ABSTRACT**

*Mulching is an agricultural technique that involves placing organic or synthetic materials on the soil around plants to provide a more favourable environment for growth and development of plant. Mulch, being a natural resource, has become one of the most effective technologies for optimum yield and quality enhancement of crops besides reducing the cost of production. Mulching is the process of covering soil with matter such as leaves, straw or peat placed around plants to prevent the evaporation of moisture, the freezing of roots and the growth of weeds. This technology is boon mainly for horticulture crops especially vegetable crops by increasing growth and yield of plants as well as for conservation of soil and water.*

**Keywords:** *Mulching, synthetic materials, soil conservation, evaporation, growth, yield*

### **I. Introduction**

Mulch is a layer of material applied to the surface of an area of cultivated soil or it is any material used to cover the surface of cultivated soil to protect plant roots from heat, cold, or drought, to keep fruit clean, or to control weeds. Mulches help to make more attractive, higher yielding vegetable gardens. The practice of mulching depends upon season, nature of crop grown, purpose of mulching and availability of mulching material. Mulches act as an insulating barrier between the soil and the air and thus play obvious role in moderating soil temperature. Mulches soil remains cooler in summer and comparatively warmer in the winter than the adjacent unmulched soil. The other benefits including improvement of soil physical and chemical properties, increment the soil organic matter, the suppression of weeds, insects and pest pressure may favor the cultivation. With the increasing demand of horticultural produces and health consciousness among people it has become imperative for us to produce more as well as good quality produce to sustain in the international market. Apart from using high yielding varieties and good agricultural practices, there is a need to utilize environmental/biological energy for higher production. Effective and economical utilization of natural resources by low cost technologies is judicious and adaptable. Of late, mulch, being a natural resource, has become one of the most effective technologies for optimum yield and quality enhancement of crops besides reducing the cost of production. The English word mulch is probably derived from the German word "molsch" meaning soft, beginning to decay, which apparently referred to the gardeners. Another meaning is the use of straw and leaves as a spread over the ground as mulch (Jack *et al.*, 1955).

**What is mulching?**

It is a protective covering usually of organic matter such as leaves, straw or peat placed around plants to prevent the evaporation of moisture, the freezing of roots and the growth of weeds.

OR

Mulches are loose covering or sheets of material placed on the surface of cultivated soil. Mulches can be applied to bare soil or cover the surface of compost in containers.

OR

Mulching can also be defined as the process of covering soil around the plant root area with a view to insulate the plant and its root from the effect of extreme fluctuations.

**Important functions and Action of mulch**

<b>Function</b>	<b>Action</b>
<b>Moisture Conservation</b>	Evaporation is suppressed and infiltration of water is enhanced by layer of mulch
<b>Soil Temperature</b>	Heat transfer from solar radiation is reduced in summer, roots may be protected from cold air temperature in winter
<b>Weed control</b>	The mulch layer is too thick or impenetrable for weed seedling to emerge.
<b>Control Erosion</b>	Water movement across the rough surface of mulch is slowed and infiltration is increased.
<b>Disease control</b>	Mulch is a protective layer between soil and plant preventing soil borne disease transmission to plants, keeping produce off soil or suppressing disease growth in soil.
<b>Insect-pest control</b>	Mulch act as barrier to insect keeping adults from entering the soil and laying eggs

**Advantages of mulching**

Mulching is extremely advantageous for number of reasons-

1. It helps in conserving moisture by reducing the amount of soil water loss through evaporation and reduces the need of frequent watering.
2. It prevents/reduces the soil erosion and compaction from heavy rains and aid in water penetration rate.
3. It maintains a more even soil temperature. They act as insulators, keeping the soil warmer during cooler weather and cooler during warm months of the year.
4. It helps in preventing/minimizing the weed growth and lessening the amount of herbicide requirement.
5. It creates ideal environment for earthworms and other beneficial soil microorganisms.
6. It improves soil texture and organic matter helps in making the soil friable.
7. It helps in increasing root growth of the plant.
8. It significantly improves stand establishment of many vegetable crops.
9. It is cheaper and safer technique and involves no phytotoxicity or herbicide residue.
10. Mulching prevents root/tuber crops such as potatoes, radishes etc. from turning green.
11. Reduction in fertilizer losses, especially 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.
12. Mulching also control pests and diseases.
13. Farmers can easily adopt mulching and get benefits.

### **Disadvantages of mulching**

1. Limited availability of mulch material like husk, hay, saw dust etc.
2. Residue mulch is available at certain period only.
3. Difficulties in the removal and disposal of mulch particularly of synthetic mulch.
4. Specialized equipments are required for special operations and add more expenditure in the cost.
5. Mulch if applied too thickly may hinder seedling emergence by forming an impermeable barrier.
6. It is labour intensive process and need expertisation and experience.
7. It can introduce (particularly organic mulches) new pests, diseases into the main field when straw, peat, woodchips are used as mulching material along with infected weed seeds.
8. Plastic mulching is not sustainable or environment friendly.
9. Clear plastic mulch promotes weed growth that in turn deprive both soil moisture and nutrients from the crop. This mulch can offer greater soil warming capabilities over black plastic mulch.
10. Carbon rich materials create a risk of N- immobilisation. When organic matter is applied to the soil, the decomposing microbes multiply quickly. For growth, they need nutrients especially nitrogen if applied plant material does not contain sufficient nitrogen, the microorganism takes it from the soil and this nitrogen is fixed temporarily in the microbes and released after some time. During this time, the microbes compete with the plants for nutrient and the crop may suffer from malnutrition. This problem can also arise when straw or grain husks are applied.

### **Types of Mulch/Mulching Materials**

*There are many types of mulching materials, but they can be divided into two general categories:*

1. Living Mulch- Cover crops (generally legumes)
2. Non-living/Dead mulch: Four types
  - a. Organic mulches (crop residues, compost, FYM)
  - b. Inorganic mulches (Polythene sheet)
  - c. Synthetic mulches (Polythene film, Polyester sheet, Latex and starch resin spray)
  - d. Soil and Dust mulch

## **II. Some important mulch materials**

### **A. Living mulch**

Live mulch is a living cover of a crop. Usually a legume crop is the best choice for live mulch. It is practiced in fruit and plantation crops. Intercrop having good weed smothering ability can also be introduced in a inter-rows of an economic crop (Pullaro *et. al.*, 2016).

### **B. Organic mulches**

These are those derived from plant and animal materials. Organic mulch properly utilized can perform all the benefits of any mulch with the possible exception of early season soil warming. However, natural mulch materials are often not available in adequate quantities for commercial operations or must be applied to the place of use. Natural materials are not easily spread on growing crops and require considerable hand labour. Organic mulches has three important role like-

- a. It conserves moisture.
- b. Capable to weed smothering.
- c. Possible to nutrient enrichment

Organic mulches consist of organic plant and/or animal residue or by-products. They are generally spread over the ground surface around established plants or over the entire growing

area in a layer 2 to 5 inches deep. Organic mulch applied immediately after a final cultivation often suppresses later emerging weeds until the crop has passed through its minimum weed-free period. Organic mulches generally lower soil temperatures and conserve soil moisture by slowing evaporation while allowing rainfall to penetrate. Normally, organic mulch is left in the field after harvest and, as it breaks down, it helps build soil organic matter.

*Commonly available organic mulches include:*

**Leaves:** Leaves from deciduous trees, which drop their foliage in the autumn/fall. They tend to be dry and blow around in the wind, so are often chopped or shredded before application. As they decompose they adhere to each other but also allow water and moisture to seep down to the soil surface.

**Grass clippings:** Grass clippings make excellent mulch for the vegetable garden. Apply fresh clippings in thin layers and allow each layer to dry before adding more. The clippings quickly dry down and additional layers can be added weekly. A few layers will stop weed seed germination. Do not place fresh clippings in thick piles, as they will mat, reducing water and air infiltration, stink and may become hydrophobic. Do not use clippings from lawns that have been treated with herbicides or other pesticides in the past month. A couple of sheets of newspaper may be used under the clippings to help control weeds.

**Peat moss:** Peat moss or sphagnum peat is long lasting popular as mulch. When wetted and dried, it can form a dense crust that does not allow water to soak in. When dry it can also burn, producing a smouldering fire. It is sometimes mixed with pine needles to produce mulch that is friable. It can also lower the pH of the soil surface, making it useful as mulch under acid loving plants.

**Wood chips:** Wood chips are a byproduct of the pruning of trees by arborists, utilities and parks, they are used to dispose of bulky waste. Tree branches and large stems are rather coarse after chipping and tend to be used as mulch at least three inches thick. The chips are used to conserve soil moisture, moderate soil temperature and suppress weed growth. The decay of freshly produced chips from recently living woody plants, consumes nitrate, this is often offset with a light application of a high-nitrate fertilizer. Wood chips are most often used under trees and shrubs. When used around soft stemmed plants, an unmulched zone is left around the plant stems to prevent stem rot or other possible diseases. They are often used to mulch trails, because they are readily produced with little additional cost outside of the normal disposal cost of tree maintenance. Wood chips come in various colours.

**Bark chips:** Bark chips of various grades are produced from the outer corky bark layer of timber trees. Sizes vary from thin shredded strands to large coarse blocks. The finer types are very attractive but have a large exposed surface area that leads to quicker decay. Layers two or three inches deep are usually used, bark is relatively inert and its decay does not demand soil nitrates. Bark chips are also available in various colours.

**Straw mulch/field hay:** Straw mulch or field hay are light weight and normally sold in compressed bales. They have an unkempt look and are used in vegetable gardens and as a winter covering. They are biodegradable and neutral in pH. They have good moisture retention and weed controlling properties but also are more likely to be contaminated with weed seeds. Straw mulch is also available in various colours. Weed free (seed free) straw makes excellent mulch for potatoes (Johnson *et. al.*, 2004). The straw protects tubers growing near the surface from sunlight, so the potato plants do not have to be mounded. (When a potato tuber is exposed to sunlight, it turns green, becoming mildly poisonous.)

**Cardboard / newspaper:** Cardboard or newspaper can be used as mulch. These are best used as a base layer upon which heavier mulch such as compost is placed to prevent the lighter cardboard/newspaper layer from blowing away. By incorporating a layer of cardboard/newspaper into mulch, the quantity of heavier mulch can be reduced, whilst improving the weed suppressant and moisture retaining properties of the mulch. However, additional labour is expended when planting through a mulch containing a

cardboard/newspaper layer, as holes must be cut for each plant. Sowing seed through mulches containing a cardboard/newspaper layer is impractical. Application of newspaper mulch in windy weather can be facilitated by briefly pre-soaking the newspaper in water to increase its weight.

**Composted sawdust:** Some organic mulches require changes in methods of garden fertilization. Sawdust, wood shavings, and ground corncobs are low in nitrogen. As they decompose, nitrogen is drawn from the soil, causing a shortage of nitrogen in the mulched vegetables. When it is time to side-dress, pull the mulch back from plants and apply fertilizer to the soil surface. With sawdust, compost, or bark, apply fertilizer to the mulch surface and water it in.

**Compost:** A few growers use compost as mulch, although the quantities required for effective weed suppression may not be economically feasible. Fully composted materials are used to avoid possible phytotoxicity problems. Materials that are free of seeds are ideally used, to prevent weeds introduced by the mulch.

**Onion/Garlic scale:** Onion and garlic scales are also used as mulch.

**Other organic residues:** Crop residues- especially like rice husk, cotton gin waste, groundnut hulls are used as mulch.

**Living Mulch:** Using cover crops as living mulch is a relatively recent management strategy that is currently being refined and evaluated in a wide range of vegetable. It is interplant or under sown with a main crop, and intended to serve the function of mulch, such as weed suppression and regulation of soil temperature. Examples of living much can be Velvet Bean, Su-babool, Barnyard grass, White Clover, Ryegrass, etc.

### **C. Inorganic mulches**

Generally polythene mulches which are different in colour may affect the temperature below and above the mulch through the absorption, transmission and reflection of solar energy. This affects the micro environment surroundings the plant. The degree of contact 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). Now a day's LDPE and LLDPE plastic films are commonly used for mulching. LLDPE black colour mulch film is most popular, owing to the twin properties of down gauging and better puncture availability.

### **D. Synthetic mulches**

It includes polythene film, polyester sheet, Latex and starch resin spray. Mulches-latex and starch resin mulch technique may eliminate polythene from the solarisation process (Parker and Riches, 1993). The spray already approached the effectiveness of polythene film when applied to soil. It performs well in sandy loam soil than in clay loam soil due to less cracking of sandy soil. However, repeated applications of the spray mulch on the soil may reduce loss of moisture or heat from the treated soil and prove more effective than its single application. They are cost effective and biodegradable (Parker and Riches, 1993). Synthetic mulches has mainly dual role like Weed control and Moisture conservation.

Synthetic mulch like black polyethylene film is most widely used as plastic mulch. It is widely available, relatively inexpensive, and comes in various widths and lengths. Plastic mulch is laid on a prepared seedbed just before transplanting or seeding a vegetable crop through holes or slits cut into the mulch. Plastic mulches are springtime mulches. They help warm the soil, permitting early planting, promote rapid growth, provide for early harvest and provide weed control. Plastic mulches reduce loss of soil moisture and protect vegetable plant fruit and leaves from soil-borne diseases. Warm-season vegetables like cucumbers, melons, squash, tomatoes, peppers, and eggplant grow better and produce more when grown on black plastic mulch than when grown on bare soil. Transplants can be set through plastic mulch by

cutting holes with a sharpened bulb planter. Use the same tool to plant seeds of widely spaced vegetables like squash and melons. While frequently used with warm-season vegetables, it can be used with cool-season vegetables like cabbage, broccoli, and cauliflower to promote early growth. It is not used with vegetables that are closely spaced in the rows.

#### **E. Soil/ dust mulch**

These are effective in improving soil moisture conservation and water use efficiency. Organic mulch moderates the temperature of underlying soil, dust mulch do not possess the same ability.

**Areas of Mulch application:** Mulching is mainly employed for-

1. Moisture conservation in rainfed areas
2. Reduction of irrigation frequency and water saving in irrigated areas
3. Soil temperature moderation in greenhouse cultivation
4. Soil solarization for control of soil borne diseases
5. Reduce the rain impact, prevent soil erosion and maintain soil structure
6. In places where high value crops only to be cultivated

#### **Selection of mulch**

It depends upon the specific purpose to be achieved such as weed control, raising of soil temperature or cooling it down, disease control, enhance plant growth etc.

#### **When to Apply Mulch**

Mulches are best applied from mid- to late spring and autumn, when the soil is moist and warm. It is best to avoid applying mulches in winter and early spring as the soil is too cold, and in summer, when it will be dry. They can be applied around new plantings or to established beds and specimen plants. Some commonly used mulched materials along with their practical application are mentioned here as under:

<b>Mulch material</b>	<b>Thickness of mulching</b>	<b>Remarks</b>
Compost	3-4 inches	Improve water retention and physical property of soil
Green leaves	3-4 inches	Chopped leaves are better
Dry leaves	6 inches	Chopped leaves are better
Grass clipping	2-3 inches	Thick layer undergoes rotting. It becomes slimy and smelly.
Bark	2-4 inches	Good for use around trees and shrubs, smaller chips are convenient to use
Wood chips	2-4 inches	Fresh wood chips are vulnerable to termite attack. Mix it with a lot of leaves and its use after composting may be beneficial.
Newspaper	¼ inch	Use text pages of newspaper which are imprinted with black ink only. Colour pages may harm the soil flora and fauna, if composted and used. Use 3-4 sheets together and cover it lightly with grass clipping, and other mulch materials, soil may be used to anchor the newspaper.
Onion/Garlic scale	2-3 inches	Cover it with soil to anchor

### **How to Apply Mulch**

Mulch should be applied little bit away from the plants. Beds and borders can be mulched entirely, taking care not to smother low growing plants or to pile mulches up against the stems of woody plants. Before apply mulch, remove weeds and water thoroughly. To be effective, biodegradable mulches need to be between at least 5 cm (2 inch) and ideally 7.5cm (3 inch) thick. Lay mulches over moist soil, after removing weeds, including their roots, when the soil is not frozen.

*Before laying mulch, the following precaution should be taken in consideration-*

- i) It should be laid on a non-windy condition.
- ii) The mulch material should be held tight without any crease and laid on the bed.
- iii) Borders (10cm) should be anchored inside the soil for about 7-10cm deep in small furrows at an angle of 45°.
- iv) The mulch material should be punctured at the required distances as per crop spacing and laid on the bed. The seeds/seedlings should be sown/ transplanted in the holes.
- v) Do not use sawdust, wood or bark chips directly in the vegetable garden. Wood takes years to decompose and sawdust can create an imbalance of Nitrogen in the soil. Instead use these mulches in pathways around the garden where they can suppress weed growth.

### **Basic properties of mulch film**

1. Air proof so as not to permit any moisture vapour to escape.
2. Thermal proof for preservation of temperature and prevention of evaporation
3. Durable at least for one crop season

### **Mulching technique in vegetable**

After taking the required length of film for crop, one end of the mulch film is anchored in the soil and the film is unrolled along the length of the row of planting. Apply FYM and fertilizers before mulching. Mulch film is then inserted (4-6") into the soil on all sides to keep it intact. The prepared transplants are planted directly into the hole. Mulches provide an insulation barrier between the soil and air, moderate the soil temperature.

### **Planting on plastic mulch**

Cut or burn a hole in the mulch and plant the seed or seedling in one operation. Use a sharp tin on a handle to easily cut a hole on tightly laid mulch at the correct spacing and then transplanting is done.

### **Mulch colour**

A mulch colour affects the temperature below and above the mulch through the absorption, temperature of air around the plant, transmission and reflection of solar energy, Soil salinity (due to lesser quantity of water used and due to reduction in evaporation and prevention of upward movement of water). This affects the micro environment surrounding the plants. The degree of contact between the mulch and the soil also affects the soil warming. The better contact the mulch has with the soil, the more effective the warming properties of the mulch (Lamont, 1999). Different colour mulches having different role which are as follows:

#### **1. Black plastic**

A solid sheet of polyethylene effectively controls annual weeds. The disadvantage of black plastic is that water and oxygen cannot pass through this material. The soil should be moist prior to laying this synthetic mulch. It warms the soil and perennial weeds may be suppressed by black plastic. Black plastic films do not allow the sunlight to pass through on to the soil.

Photosynthesis does not take place in the absence of sunlight below black film. Hence, it arrest weed growth. Before lying of plastic mulch, the soil should be moist otherwise it

warms the soil. All colour of plastic mulch control weed growth except clear plastic. Black, brown, clear plastic warm the soil, whereas white plastic cools the soil. Blue, green and silver plastic also produced greater yield than black plastic.

## **2. Clear plastic**

This mulch which increases the soil temperature more than black plastic will not able to control weeds since sunlight can reach the soil surface. Soil temperature during the day time under clear plastic can reach 8-14° F higher at the 2” depth and 6-14° F higher at the 4” depth than bare soil at the same depths due to a greater (85-95%) 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 radiations (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.

## **3. White plastic**

Light is reflected back into the atmosphere or the plant canopy from a white plastic mulch, resulting in slightly cooler (-2° F at 1” depth) soil temperature. White plastic mulches can be used to establish crops in the summer when a reduced soil temperature might be beneficial.

## **4. Silver/aluminium**

Reflective silver or aluminium mulches also give cooler soil temperature. They tend to repel aphids, which can serve as vector for various viral diseases (Lamont *et al.*,1990).

## **5. Red mulch**

According to the Virginia Corporation Extension, crops grown in red plastic produced upto 20% more tomatoes and boasted larger fruit size and weight over those grown in black plastic.

## **6. Others**

Blue, yellow, orange, grey plastic mulches are also used. The different radiation patterns that are reflected back into the canopies of various crops from these mulches affect the plant growth and development in different ways. Some colours like yellow attract certain insects like green pea aphids and cucumber beetles. Therefore, such mulches might be used in a field to grow catch crops to pull insects away from other crops. Blue coloured mulches have been shown to increase honeydew yield.

**Calculation of mulch film requirement**

Thickness			Area covered (m <sup>2</sup> /kg)	Weight (g/m <sup>2</sup> )
Micro	Gauge	Mm		
7	28	0.007	144	6.9
20	80	0.02	54	18.4
25	100	0.025	42	23
40	160	0.04	26	38
50	200	0.05	21	46

## **Precautions taken during Mulch Laying**

1. Do not stretch the film very tightly. It should be loose enough to overcome the expansion and shrinkage conditions caused by temperature and the impacts of cultural operation.



2. The slackness for black film should be more as the expansion; shrinkage phenomenon is maximum in this color.
3. The film should not be laid on the hottest time of the day, when the film will be in expanded condition.

### **III. Conclusion**

Mulching is an age old technique to conserve moisture, check weed growth, moderate soil temperature and provide micro-climate to plants. This technology is boon for the horticulture crops not only for increasing growth, development, yield but also as method of soil and water conservation. Introduction of linear low density polyethylene (LLDPE) as a mulch film has brought a revolution in agricultural water management. It is actually a boon to dryland farmers. This is one of the fastest growing plasticulture applications in the world. The use of mulches may be recognized as an important part of crop management to reduce the application of chemicals for weed and pests control as well as to decrease need of water and even mineral fertilizers. Mulching is environment friendly application to the integrated and organic systems of horticulture for especially vegetable production.

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