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Mulching in Vegetable Production: Enhancing Productivity and Resource Efficiency

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Introduction

Mulching is a widely recognized agronomic practice that involves covering the soil surface with various materials to create a favorable microenvironment for plant growth. In vegetable production systems, where crops are highly sensitive to fluctuations in soil moisture, temperature, and nutrient availability, mulching plays a crucial role in stabilizing these factors and improving overall crop performance.

Vegetable crops typically have shallow root systems and high water requirements, making them more vulnerable to moisture stress and temperature extremes compared to field crops. Under such conditions, mulching acts as a protective layer that reduces environmental stress and enhances resource use efficiency.

Black plastic mulch is widely used for its high efficiency in weed control and water conservation, though it is costly and can leave harmful residues. in contrast, grass mulch is cheaper and eco-friendly but less durable. Biodegradable mulches, made from starch-based polymers, offer a promising alternative to plastic.

Mulching is becoming essential in modern agriculture due to water scarcity, resource degradation, and the need for chemical-free weed and pest control. it reduces evaporation by blocking sunlight, maintains soil moisture, lowers soil temperature, and promotes better plant growth and survival. it also enhances water infiltration and nutrient availability while minimizing weed competition (Easmin et al., 2009; Khan et al., 2015). In summary, mulching is a sustainable, low-cost technique crucial for improving yield and quality in high-value vegetable crops, particularly under changing climatic conditions.

Intentions for Covering Holes

Tree coverings are used for a variety of reasons but water conservation and erosion control are the most important objectives of their agricultural use in arid areas. Other reasons for the use of topsoil cover include soil temperature adjustment, soil conservation, nutrient supplementation, soil structure improvement, weed control and crop quality control.

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Benefits: Soil moisture retention: Covering with mulching prevents evaporation of excess moisture. it reduces soil compaction and helps to ensure soil penetration, prevents excessive flow and checks for soil erosion.

- Soil temperature control.
- Control weeds growth.
- Reduce soil erosion.
- Prevent leaching of fertilizer.
- Reduce winter damage by reducing temperature fluctuations, lowering water. loss of plants and a decrease in the crown of plants and roots.
- Reduce fruit rot by removing contact between the fruit and the soil.
- Provides a conductive environment for plant growth.
- improve seed germination.
- Premature maturation.

Barriers to covering a hole

- Covering tree seedlings is a lot of work.
- inorganic holes are expensive.
- Warm humidity allows the spread of disease and pests.
- The use of polythene mulch creates a wet anaerobic state that leads to root death.
- Slow-growing plants are suppressed.
- Holes in dry trees sometimes pose a risk of fire.

Types of mulching holes

- Holes in Organic trees
- Holes in inanimate(inorganic) trees

Organic tree holes:

The incorporation of a layer of plant and animal fossils to protect the soil and provide a good environment for plant growth. Natural mulches rot over time and return nutrients to the soil. Organic holes, such as leaves, compost, grass or sawdust (Kayum et al. 2008).

Types of Organic Mulches

A. **Paper cover:** Crushed and parchment paper is used. Apply two to three layers of paper at a time and cover with organic material such as a leaf cover or pieces of grass to hold them tight.
B. **Vegetation cover with dry leaf seedlings:** Leaves work best when dropped before being applied as a cover for tree seedlings. it is easily available and inexpensive. Example: Sugarcane

leaves or bananas and other leaves.

C. **Sawdust mulch:** it can decompose quickly and combine on its own but requires high nitrogen to decompose. Sawdust is used after treatment against termites.

D. **Grass and grass cover tree seedlings:** ideal for winter protection. if used in the summer, be sure to add extra nitrogen to the soil. Example: paddy straw.

E. **Manure / compost cover:** These cover material is placed in a layer of 2 - 3 ”layers on top of the plants or soil and is used for good looks. Compost needs to rot well before laying; otherwise it can damage the plants. in addition, covering these materials will improve soil fertility by increasing the state of organic carbon.

Inorganic tree coverings:

inorganic tree coverings are often used to create weed boundaries. inorganic mulch, such as rocks or stones and plastic fi lms do not rot easily. These are also used for decorative purposes

Inorganic Mulch species

Basically, there are two types of mulch in terms of material used. They are as follows:

A. **Plastic holes:** By carefully choosing the shape of the plastic cover as a color and thickness, it is possible to control the surrounding soil surface.

- Black plastic mulch: Black plastic film does not allow sunlight to pass through the soil. Thus, photosynthesis does not occur in soil where there is no sunlight under a dark film. Black plastic mulch helps retain moisture and control weed growth. However, it may increase soil temperature. it gives harvest in advance for 7-14 days. it also helps to increase yields especially for leafy vegetables (Ashrafuzzaman et al. 2011).
- Clear and transparent plastic mulch: Let the sunlight pass and the weeds grow, however, by using a herbicide cover on the inner side, weed growth can be observed. it is very effective as a soil-based solarization film to reduce soil-borne diseases and other weeds. This is an application for raising children by heating the beds before sowing the seeds to grow a nursery, which provides 100% seed germination and disease-free kindergarten. Transparent films work in hilly areas to increase soil temperature in cold winter weather.
- Two-color plastic mulch: Also known as wavelength selective / photo selective film is designed to absorb certain wavelengths of the sun's rays, which change the spectrum of sunlight passing through a film or return to plant skin. it has had a significant effect on plant growth and development. The effects are warming of the soil temperature and suppressing weed growth. Examples:
    1. Yellow / Black: Attract certain insects and trap them, which protect them from disease.
    2. White / Black: Reduce soil temperature.
    3. Silver / black: Expels aphids and trips.
    4. Red / black mulch: Slow rotation that allows the rays to pass & warm soil but also exposes the rays behind the plant bed changes the ratio of R: FR light, which leads to plant changes, flower growth and nutrient fluctuations in early infection and proliferation. Veza. This mulch is mainly used in tomato plants.

Perforated tree holes:

Impaired mulch: Mulch contains elements of iron and copper that break down after exposure to light and degrade very slowly. These flower buds break under ultraviolet light.

Bio-degradable mulch: it disperses under natural conditions and is mixed into the soil after cover time. Mulches are made from a combination of starch and decaying plastic.

Aluminum foil or Aluminum painted mulch: This light mulch under the leaves may repel aphids and thrips. When vector insects are repelled, germ transmission also decreases.

Rock mulch:

Widely used in home garden and kitchen. The stones do not retain moisture but retain heat in the soil.

installation of mulch film

Tractor plastering equipment is designed and operational.

Selection of mulch films

The choice of film color depends on the specific objective to be achieved such as weed control, soil temperature or cooling or disease control or improved plant growth etc. A film with a diameter of 90 cm & 120 cm is widely used.

Mulch Size:

The size of the mulch should be commensurate with the type and age of the crop

Table: 1 Mulch size should be used for vegetable crops

S.No.	Mulch material	Thickness of mulching
1	Compost	3-4 inches
2	Green leaves	3-4 inches
3	Dry leaves	6 inches
4	Grass clipping	2-3 inches
5	Paper	3-4 sheets
6	Onion /Garlic scale	2-3 inches
7	Plastic mulch	
8	Annuals- Short duration crop	20-25 micron
9	Biennial- Medium duration crop	25-50 micron
10	Perennial- Long duration crop	50-100 micron

impact of mulching on crop production and soil health

- **Soil Temperature:** Mulching regulates soil temperature by affecting radiation balance and moisture evaporation. Organic residues act as insulators, stabilizing root zone temperatures and protecting young seedlings (Parmar et al., 2013).
- **Germination and Growth:** Some organic mulches may release phytotoxic substances that affect seed germination and plant growth. However, grass mulches have shown better outcomes in promoting early vegetation.

- **Plant Microclimate:** Mulching improves the microclimate by reducing soil water evaporation and moderating root zone temperature. While moderate temperature rise encourages root growth, excessive heat—especially under plastic mulch—can hinder root development.
- **Soil Fertility:** Plastic mulches, especially black polyethylene, reduce nutrient loss and help retain soil moisture, preserving essential nutrients like Mg and Ca. Studies show improved tomato yields and reduced nitrate leaching under mulched conditions.
- **Soil Biological Properties:** Mulching enhances microbial activity by maintaining moisture and moderate temperature. Organic mulches also promote higher earthworm populations—up to **155% more** than in bare soil (Mahmood et al., 2002).
- **Soil Structure:** Organic mulches contribute to increased soil organic carbon, improving soil aggregate stability and overall structure.
- **Groundwater Conservation:** Mulching significantly reduces irrigation needs—by **20–46%**—through better moisture retention. Plastic mulches also improve water-use efficiency in crops like tomatoes.
- **Crop Growth and Yield:** Black polyethylene mulch supports **early and higher yields**, notably in crops like **muskmelon**, by optimizing soil conditions and minimizing stress during early growth stages.

Conclusion:

Organic farming is more than just avoiding chemical fertilizers and pesticides—it's a holistic approach focused on maintaining soil fertility and managing pests naturally. This system emphasizes building healthy soil through the use of organic matter and minimal tillage. Organic residues are left to decompose in the field, and weeds are controlled through mulching and natural suppression. Mulching plays a vital role in organic farming by reducing soil erosion, retaining moisture, suppressing weeds, regulating temperature, and gradually releasing nutrients. The use of black polythene mulch has significantly improved the growth and yield of various vegetable crops.

in conclusion, mulching is a beneficial and cost-effective practice for vegetable farmers. it enhances productivity and fruit quality, making it a practical strategy for sustainable and high-yielding organic agriculture.

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