

Role of Cover Crops and Mulching in Weed Suppression

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INTRODUCTION

Weeds compete aggressively with cultivated crops for essential resources such as nutrients, water, light, and space, leading to reduced crop growth, yield, and quality. In severe cases, yield losses due to weeds may range from 30 to 70 percent, depending on crop type, weed flora, and management practices. Traditionally, weed control has relied heavily on chemical herbicides due to their rapid and effective action. However, indiscriminate and continuous use of herbicides has led to the evolution of herbicide-resistant weed biotypes, environmental pollution, soil health degradation, and increased production costs.

Integrated Weed Management (IWM) promotes the judicious combination of cultural, mechanical, biological, and chemical methods to achieve sustainable weed control. Among cultural practices, the use of cover crops and mulching has gained significant attention due to their multifunctional benefits. These practices not only suppress weeds effectively but also enhance soil fertility, conserve moisture, reduce erosion, and improve system resilience, making them indispensable components of organic farming, conservation agriculture, and climate-smart agriculture.

2. Role of Cover Crops and Mulching in Weed Management

Cover crops are plants that are grown in between the main crops or in the off-season to cover the soil and protect it from erosion, compaction, and nutrient leaching. They are also known as green manures, catch crops, or agronomic cover crops, depending on the purpose they serve. Their main role in weed management is to suppress weed growth by shading, smothering and competing for resources. Apart from weed suppression, cover crops and mulching also contribute to soil improvement, especially in terms of organic matter, water holding capacity, and microbial diversity. Subsequently, these practices enhance nutrient cycling and agro-ecosystem stability.

2.1 Concept of Cover Crops

Cover crops are non-commercial crops grown primarily to protect and improve soil rather than for direct economic returns. They are usually cultivated during fallow periods, off-seasons, or between rows of main crops. Cover crops can be broadly classified into legumes, grasses, and brassicas, each offering specific benefits.

- ✓ **Legumes** (e.g., cowpea, sunn hemp, clover, mung bean) improve soil fertility through biological nitrogen fixation.
- ✓ **Grasses** (e.g., rye, oats, sorghum, pearl millet) produce large biomass and are highly effective in weed suppression.
- ✓ **Brassicas** (e.g., mustard, radish) are known for their biofumigation and allelopathic effects.

2.2 Mechanisms of Weed Suppression by Cover Crops

a) Physical Suppression

Cover crops form a dense canopy that shades the soil surface, significantly reducing light penetration required for weed seed germination. This shading effect is particularly effective against light-sensitive weed species and during early crop growth stages.

b) Resource Competition

Rapidly growing cover crops compete effectively with weeds for nutrients, soil moisture, and space. Vigorous root systems and fast biomass accumulation limit resource availability to weeds, reducing their establishment and growth.

c) Allelopathy

Certain cover crops release allelochemicals through root exudates, leaching, or decomposition of residues. These chemicals inhibit weed seed germination, root elongation, and seedling growth. Rye, sorghum-sudangrass, mustard, and sunflower exhibit strong allelopathic potential against a wide range of weeds.

d) Reduction of Soil Weed Seed Bank

Repeated use of cover crops limits weed seed production and prevents seed dispersal. Over time, this results in depletion of the soil weed seed bank, leading to long-term weed suppression.

2.3 Advantages of Cover Crops

- ✓ Effective suppression of annual and perennial weeds
- ✓ Improvement in soil organic carbon and aggregation

- ✓ Enhanced nutrient recycling and nitrogen fixation
- ✓ Reduction in soil erosion and surface runoff
- ✓ Improvement in soil microbial activity and biodiversity
- ✓ Enhanced resilience against climatic stresses

3. Mechanisms of Weed Suppression by Cover Crops and Mulching

The mechanisms by which cover crops and mulching suppress weeds are complex and multifactorial. The physical suppression involves the competition for light, space, and water practically. Heavy cover crops can shade out small weeds and thus eliminate them physically. Mulches, too, under certain conditions, can accomplish the same by completely covering the weeds with the mulch layer. This not only stops weed germination but also kills the existing ones.

3.1 Concept of Mulching

Mulching refers to covering the soil surface with organic or inorganic materials to protect soil and modify the microclimate. Mulches act as a physical barrier that inhibits weed emergence while providing multiple agronomic benefits.

3.2 Types of Mulches

a) Organic Mulches

- ✓ Straw, crop residues
 - ✓ Dry leaves and grass clippings
 - ✓ Compost, farmyard manure, sawdust
- Organic mulches gradually decompose, enriching soil organic matter and improving soil structure.

b) Inorganic Mulches

- ✓ Plastic mulches (black, silver-black, biodegradable films)
- ✓ Woven fabrics and polythene sheets

Plastic mulches are widely used in horticultural crops due to their high weed control efficiency and moisture conservation ability.

3.3 Mechanisms of Weed Control by Mulching

a) Light Exclusion

Mulches block sunlight from reaching the soil surface, preventing germination of photosensitive weed seeds.

b) Physical Barrier

A thick mulch layer mechanically restricts weed seedling emergence by obstructing shoot penetration through the soil surface.

c) Soil Microclimate Modification

Mulches regulate soil temperature and moisture, creating unfavorable conditions for weed establishment while promoting crop growth.

3.4 Advantages of Mulching

- ✓ Significant reduction in weed density and biomass
- ✓ Conservation of soil moisture and reduced evaporation losses
- ✓ Moderation of soil temperature
- ✓ Improvement in crop yield, quality, and earliness
- ✓ Reduction in labor and herbicide use

4. Types of Cover Crops and Mulching in Weed Suppression

Cover crops can be divided based on their purposes into winter/hairy vetch, rye, clover, etc. Summer cover crops include millet, cowpea, sunflowers, etc. Different cover crop mixes can also be used that meet specific soil requirements or environmental conditions.

Weed control over mulching depends largely on the product and application methods. The main types of mulch are organic, inorganic, and chemical (herbicides). Organic mulching materials include straw, leaves, bark, grass, etc. While using biodegradable plastic is one way of inorganic mulching, and no-till practices are another. Chemical control includes the use of slow-release herbicides or application of the usual herbicides at reduced doses.

5. Advantages of Cover Crops and Mulching

The main advantage of using cover crops as a weed management strategy is their effectiveness combined with the advantages of being non-chemical methods. Their success is largely attributed to their ability to bring about certain changes to the weed ecology and helping crops to utilize the resources more efficiently.

Another important advantage of cover crops and mulching is soil improvement. The organic matter content, water holding capacity, and microbial diversity are the main soil quality aspects that these practices contribute to positively.

6. Limitations of Cover Crops and Mulching

Despite these and some other advantages, there are limitations to cover crops and mulching. Their biggest drawback is the cost associated with their establishment, which is not always compensated for by the benefits derived. Cover crops, for instance, usually do not yield benefits in the same growing season that they are applied. Another limitation of cover crops is the weed seed bank. If the weed seed bank is high, the new plants will infest and waste the cover crop's resources straight away. Planting and managing

cover crops may, therefore, be counterproductive at times.

7. Practical Applications

Incorporating cover crops and mulching into conventional weed control strategies will require a change in the mindset of farmers and growers who have relied on chemical control. Therefore, it will be critical to provide appropriate information and support to the farmers and other stakeholders involved.

For example, the use of winter cover crops generally increases the need for herbicide treatments. Nevertheless, the weed control cost in the following summer is much less than when proper cover cropping and undersowing practices are not used at all.

CONCLUSION

On the global scale, weeds continue to be among the main obstacles preventing farmers from getting the maximum yields. These plants not only compete with the main crops for nutrients, light, and water but they also harbor agricultural pests and diseases. Moreover, the widespread use of chemical herbicides as a control option is creating serious environmental and health hazards. Therefore, the need to incorporate alternative and non-harmful control techniques on the farm is becoming ever more urgent. In this regard, cover crops and mulching are giving hope to farmers as they are already being used in various forms worldwide. However, their full potential can only be accessed if their numerous advantages are realized and growers supported with knowledge, functionality, and quite often the right equipment too.

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