



Efficient Weed Management in Organic Production System

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Abstract

Weed control is critical to maintaining agricultural yield, farm profitability and food security in India, where weeds account for one-third of pest-related losses. Herbicidal-based weed management is very popular among the various weed control solutions because it is very effective at managing weeds while also saving a significant amount of time and effort. Over-reliance on herbicides, like other pesticides, has been criticized for a number of reasons, including herbicide resistance in weeds, weed shifts, surface and groundwater water pollution, herbicide residues in food chains, toxicity on non-target organisms, risk in farming systems, and so on. The growing concern about pesticide side effects has largely driven the emphasis on organic weed management. Organic weed management is a multi-pronged approach that includes preventive, physical, cultural or ecological, biological, allelopathic and organically derived chemical-based approaches.

Keywords: Corn gluten meal, Herbicide, Organic herbicide, Weed shift

Introduction

India has a wide variety of agroclimatic conditions and soil types. Weeds of various species have a wide range of effects on agriculture and farming systems. Weeds reduce crop productivity by 10-80%, lower product quality, and cause health and environmental issues. Human weeding has always been a major component of weed control in India. Increased labor shortages and costs, on the other hand, are causing farmers to employ labor and cost-cutting measures. Indian farmers practice integrated weed management (IWM), with the level of adoption varying from farm to farm. The continuous application of isoproturon, combined with rice-wheat monocropping rotation, has resulted in the evolution of resistance in *Phalaris minor* Retz. in Northern India. Herbicide efficacy is the focus of most weed management research in India.

Weeds: Major Biotic Stress and Potential Yield Loss

Weeds can indeed be considered a major biotic stress in various ecosystems, including agricultural fields, gardens, and natural habitats. Weeds can compete with desirable plants for resources, allelopathy, pest and disease vectors, habitat modification, seed production and persistence, and resistance to herbicides. These factors can lead to decreased

yields and economic losses. Allelopathy can inhibit the growth of other plants, pest and disease vectors can find refuge in weed populations, habitat modification can alter the physical structure and composition of ecosystems, seed production and persistence can remain viable in the soil for extended periods and resistance to control methods can develop.

Weeds not only cause significant quantity losses, but they also have an impact on crop quality. Weeds reduce wheat grain yield by 10 to 52%, depending on the nature and intensity of the weeds, as well as the duration of crop weed competition, climate, agronomic practices, and the relative emergence pattern of weeds in relation to crop hazards (Rao and Chauhan, 2015). *P. minor* has been reported to be a serious threat to wheat cultivation among grassy weeds. Even a moderate infestation of *P. minor* reduces wheat grain yield by 15-20%.

Weed Management: Predominantly Herbicidal

Chemical weed management, also known as herbicide use, has gained popularity due to its efficiency, effectiveness, cost-effectiveness, crop protection, convenience, and scalability. Herbicides are designed to target and kill weeds selectively while minimizing harm to desirable plants. They

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can be applied directly to the targeted areas, reducing manual labor and saving time. However, it is important to follow proper guidelines, regulations and safety precautions when using herbicides to mitigate potential environmental and health concerns.

Weed Shift

A change in the composition or frequencies of weeds within a defined area, whether it may be a weed population or community, is known as a weed shift. This phenomenon can be caused by either natural or human-made environmental changes within an agricultural system. When weed management practices fail to control an entire weed community or population, weed shifts can occur. These management practices may include the use of herbicides or other techniques such as tillage, manure application, or harvest scheduling, which can alter the composition of weed species. Certain species or biotypes may be killed or affected by the management practices, while others may be tolerant or resistant, and some may even be dormant during application. The species that are not controlled have the potential to grow, reproduce, and increase within the community, ultimately leading to a shift in the weed population or community.

Threats Coming from Increased Use of Herbicides

The increased use of herbicides can pose several potential threats, such as the development of herbicide-resistant weeds, ecological impact, soil health and microbial communities, human health concerns, and water contamination. Repeated and widespread use of herbicides can lead to the evolution of herbicide-resistant weeds. These resistant plants are capable of surviving herbicide treatments that would typically kill or control susceptible weed species. Herbicides can find their way into water bodies through runoff or leaching, affecting aquatic organisms and disrupting aquatic ecosystems. Excessive and indiscriminate herbicide use can negatively impact soil health. Herbicides can alter soil microbial populations and their diversity, potentially leading to imbalances in the soil ecosystem. Prolonged exposure to certain herbicides has been associated with various health issues, including respiratory problems, skin irritation, reproductive disorders, and even cancer. To mitigate these threats, it is important to adopt sustainable and integrated weed management strategies, such as crop rotation, mechanical cultivation, biological control, and targeted herbicide use, while minimizing the overall reliance on herbicides.

Organic Weed Management

Organic weed management refers to the use of natural and environmentally friendly methods to control weeds without relying on synthetic herbicides or chemical treatments. It involves employing various strategies to prevent weed growth, disrupt their lifecycle, and manage them effectively. Here are some common organic weed management practices:

1. Mulching: Mulching is a popular method for suppressing weed growth. Applying a layer of organic mulch, such as

straw, wood chips, or leaves, around plants and in garden beds can smother weeds by blocking sunlight and preventing their germination.

2. Hand weeding: Regularly inspecting your garden and manually removing weeds by pulling them out from the root is an effective organic weed management technique. It's essential to remove the entire weed, including the roots, to prevent regrowth.

3. Cultivation: Using hand tools like hoes or cultivators to disturb the soil surface can disrupt weed seedlings and prevent them from establishing themselves. However, be cautious not to disturb the roots of desirable plants.

4. Cover crops: Planting cover crops in between main crops helps suppress weeds by competing for nutrients, sunlight, and space. Cover crops like clover, buckwheat, or rye can act as living mulches and help prevent weed growth.

5. Crop rotation: Practicing crop rotation helps break the weed lifecycle. Different plant species have different weed vulnerabilities, and rotating crops can disrupt the weed's ability to establish and spread.

6. Solarization: This method involves covering the soil with a clear plastic sheet to trap heat from the sun, effectively heating the soil and killing weed seeds and seedlings. Solarization is particularly useful for preparing garden beds before planting.

Biological Weed Management

Biological weed management, also known as biological control or biocontrol, refers to the use of living organisms to manage or suppress weed populations. These organisms, which can include insects, pathogens, or other organisms, are natural enemies of the target weed species and can help reduce their growth and spread. Biological weed management is often employed as an alternative or complement to chemical herbicides, with the goal of reducing the environmental impact of weed control. Biological weed management relies on identifying and utilizing natural enemies of the target weed species. Host specificity is important, and the introduced organisms are released into the affected area. Regular monitoring and evaluation are essential to assess the effectiveness of biological control agents and their impact on the weed population. Integrated Weed Management (IWM) approaches can provide more effective, sustainable and long-term weed control solutions. Limitations include taking time for the natural enemies to establish and exert their impact on the weed population, and the selection and implementation of biological control agents should be carried out by trained professionals.

Organically Derived Herbicides

An organically derived herbicide refers to a type of weed killer or herbicide that is derived from natural sources and is approved for use in organic farming or gardening practices. These herbicides are typically made from plant-based or mineral-based ingredients and are designed to control or eliminate unwanted weeds while minimizing environmental impact.

Organically derived herbicides can be effective in managing

weeds without relying on synthetic chemicals commonly found in conventional herbicides. They are commonly used in organic agriculture, where the use of synthetic pesticides is restricted. These herbicides are also popular among gardeners and homeowners who prefer more natural approaches to weed control.

Examples of organically derived herbicides include:

1. *Acetic acid-based herbicides*: These herbicides use vinegar, which contains acetic acid, as their active ingredient. They are commonly used to control broadleaf weeds and are generally non-selective, meaning they can harm or kill any plant they come into contact with.

2. *Citric acid-based herbicides*: These herbicides use citric acid, which is derived from citrus fruits, as their active ingredient. They are effective against certain types of weeds and are often used as spot treatments.

3. *Essential oil-based herbicides*: Some herbicides use essential oils derived from plants, such as clove oil, peppermint oil, or cinnamon oil, as their active ingredients. These oils can have weed control properties and are used in various organic herbicide formulations.

4. *Corn gluten meal*: Corn gluten meal is a by-product of the corn milling process and has shown some pre-emergent herbicidal properties. It can be used to prevent weed seed germination and is commonly applied as a natural herbicide in lawns and gardens. (Webber *et al.*, 2012).

Conclusion

The management of weeds through organic means can be a viable substitute for chemical methods, provided that it is executed correctly. There is a requirement for more extensive exploration and advancements in the field of weed control through biological control and allelopathy to increase their application and practicality in the field. Additionally, utilizing innovative techniques like “weed suppressive soil” and robots equipped with welding technology can be a progressive step towards achieving this goal in the near future.

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