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Main plant integrated protection directions in organic agriculture conditions: A review

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Abstract

This review highlights the importance of adopting sustainable and environmentally friendly practices in organic agriculture. Integrated pest management (IPM) is a key aspect of organic farming that incorporates a combination of cultural, biological, and chemical methods to prevent, monitor, and control pests. Cultural practices such as crop rotation, inter-cropping, companion planting, and soil fertility management are effective ways to create a healthy ecosystem that supports plant growth while minimizing the use of synthetic inputs. Biological controls, such as the use of natural predators, parasites, or pathogens, provide an alternative approach to managing pests while reducing harm to beneficial organisms and the environment.

Keywords: organic agriculture, integrated pest management, cultural practices, biological control, crop rotation, pest infestations.

1. Introduction

Organic agriculture has been growing rapidly in recent years, driven by an increasing demand for food produced using sustainable and environmentally friendly practices. Organic farming relies on ecological processes, biodiversity, and natural solutions to produce crops while minimizing the use of synthetic inputs such as fertilizers, pesticides, and genetically modified organisms (GMOs). One key aspect of organic farming is integrated pest management (IPM), which involves using a combination of cultural, biological, and chemical methods to prevent, monitor, and control pests. However, organic farmers face unique challenges in managing pests due to restrictions on the use of synthetic pesticides. This paper reviews the main plant integrated protection directions in organic agriculture conditions, including cultural practices, biological controls, and alternative chemical agents.

2. Material and Methods

Overall, this study employed a literature review, data collection, analysis, and synthesis approach to examine the various components of integrated pest management in organic agriculture. The aim was to provide a comprehensive understanding of the methods used and their implications for sustainable pest control in organic farming.

Literature Review: A comprehensive review of existing literature and research on integrated pest management in organic agriculture was conducted. This involved analyzing academic papers, books, reports, and relevant sources to gather information on cultural practices, biological controls, and alternative chemical agents used in organic farming.

Data Collection: Information on cultural practices, including crop rotation, inter-cropping, companion planting, and soil fertility management, was collected and synthesized from various sources.

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This involved examining studies and practical experiences of organic farmers to understand the effectiveness of these practices in pest management.

Analysis and Synthesis: The collected data on cultural practices, biological controls, and alternative chemical agents were analyzed and synthesized to identify common trends, techniques, and outcomes. The strengths, limitations, and environmental implications of each method were evaluated.

Conclusion and Recommendations: Based on the analysis and synthesis of the data, conclusions were drawn regarding the effectiveness and sustainability of integrated pest management strategies in organic agriculture. Recommendations were provided for improving pest management practices in organic farming, including areas for further research and development of more effective and environmentally friendly approaches.

3. Results and Discussion

Cultural Practices refer to methods of farming that create an environment unfavorable to pests. Crop rotation is one such practice that helps prevent pest buildup by disrupting their life cycles. By rotating crops, pests are unable to adapt to a single crop, reducing the risk of infestation. For example, planting corn one year followed by soybeans the next can reduce the population of corn rootworms, which are attracted to corn but not soybeans. Similarly, inter-cropping is another cultural practice that provides a diverse habitat for beneficial insects. Companion planting is yet another strategy used by organic farmers. For example, planting marigolds with tomatoes can repel nematodes, while planting garlic around cabbage can deter cabbage moths.

Soil fertility management is also critical in organic farming. Soil amendments such as compost, manure, and green manures provide nutrients to plants while increasing soil biodiversity. Healthy soil supports a diverse ecosystem of microorganisms, which contribute to pest control by suppressing harmful pathogens and promoting beneficial bacteria and fungi. For example, adding compost to soil can increase the number of beneficial microbes, which can help suppress harmful diseases like Phytophthora root rot.

Cultural practices are an essential part of organic farming, which aims to produce food in a way that is environmentally sustainable, socially responsible, and economically viable. These practices focus on creating a healthy ecosystem that supports plant growth while minimizing the use of synthetic inputs such as pesticides, fertilizers, and herbicides. Cultural practices include crop rotation, inter-cropping, companion planting, and soil fertility management.

Crop rotation is a method of alternating the crops grown in a particular field over time. This practice disrupts the life cycles of pests and diseases that are specific to certain crops, reducing their populations and preventing infestations. For example, corn rootworms are attracted to corn but not soybeans. By rotating between these two crops, farmers can reduce the population of corn rootworms, making it less likely for them to cause significant damage to the corn crop. Crop rotation also helps to prevent nutrient depletion by ensuring that different crops are planted in the same field, allowing soil to recover from the previous season's crop.

Inter-cropping is another cultural practice that involves planting different crops together in the same field. This practice provides a diverse habitat for beneficial insects, which can help control pest populations. For example, growing beans alongside corn can attract ladybugs, which eat aphids that would otherwise attack the corn. Inter-cropping also has other benefits, such as reducing soil erosion, increasing biodiversity, and improving soil fertility.

Companion planting is a strategy used by organic farmers to create mutually beneficial relationships between plants. Certain plants have natural properties that can repel pests or improve the health of neighboring plants. For example, planting marigolds with tomatoes can help repel nematodes, which are microscopic worms that can damage

tomato roots. Similarly, planting garlic around cabbage can deter cabbage moths, which lay eggs on cabbage leaves, leading to larvae that can destroy the crop. Companion planting can also improve soil health by attracting beneficial insects and providing nutrients to nearby plants.

Soil fertility management is another critical aspect of organic farming. Healthy soil is essential for plant growth and provides a diverse ecosystem of microorganisms that contribute to pest control by suppressing harmful pathogens and promoting beneficial bacteria and fungi. Soil amendments such as compost, manure, and green manures provide nutrients to plants while increasing soil biodiversity. Compost is made from organic matter such as food waste, leaves, and grass clippings that have been decomposed by microbes. Adding compost to soil can increase the number of beneficial microbes, which can help suppress harmful diseases like Phytophthora root rot.

Manure is another soil amendment used in organic farming. Cows, horses, pigs, and chickens are commonly used to provide manure for fertilizing crops. Manure is rich in nitrogen, phosphorus, and potassium, which are essential nutrients for plant growth. However, it must be composted before being used to prevent the spread of harmful pathogens such as E. coli and Salmonella. Green manures are plants that are grown specifically for the purpose of adding nutrients to the soil. These plants are typically legumes such as clover or alfalfa that can fix nitrogen from the air and convert it into a form that plants can use.

In conclusion, cultural practices such as crop rotation, inter-cropping, companion planting, and soil fertility management are essential components of organic farming. These practices focus on creating a healthy ecosystem that supports plant growth while minimizing the use of synthetic inputs such as pesticides and fertilizers. By using these methods, farmers can reduce the risk of pest infestations, improve soil health, and produce food in a way that is environmentally sustainable, socially responsible, and economically viable. Organic farming practices promote a more holistic approach to agriculture that considers the health of the soil, the health of the plants, and the health of the people who consume the food produced.

Biological Controls Biological control involves using natural predators, parasites, or pathogens to control pests. This approach harnesses the power of nature to regulate pest populations without harming beneficial organisms. Examples of biological control include releasing predator insects like ladybugs or lacewings to feed on aphids or spraying Bacillus thuringiensis (Bt), a naturally occurring bacterium that kills caterpillars.

In addition to predators and parasites, microorganisms like fungi and bacteria can also be used as biocontrol agents. Trichoderma fungi, for instance, can suppress soil-borne plant diseases by outcompeting harmful organisms. Similarly, the bacterium Pseudomonas fluorescens produces antibiotics that inhibit the growth of pathogenic bacteria.

Another type of biological control is the use of pheromones to disrupt insect mating patterns. By releasing synthetic female sex pheromones, male insects become confused, reducing their ability to locate females for mating. This strategy can be particularly effective for controlling pests like codling moths in apple orchards.

Biological controls are an alternative approach to pest management that involves using natural predators, parasites, or pathogens to control pests. This method relies on nature to regulate pest populations without causing harm to beneficial organisms or the environment.

One example of biological control is the use of predator insects like ladybugs or lacewings to feed on aphids. These predator insects are released into crops to control aphid populations naturally. The ladybug, also known as the ladybird beetle, is a well-known predator insect that feeds on aphids and other soft-bodied insects. Lacewings are another type of

predator insect that feed on aphids and other pests, including mites and thrips.

Another form of biological control is the use of *Bacillus thuringiensis* (*Bt*), a naturally occurring bacterium that kills caterpillars. *Bt* produces a protein that is toxic to certain insects but harmless to humans and other animals. When sprayed on plants, Bt serves as a biological pesticide, killing caterpillars that try to eat treated leaves.

Microorganisms like fungi and bacteria can also be used as biocontrol agents. Trichoderma fungi, for instance, can suppress soil-borne plant diseases by outcompeting harmful organisms. Trichoderma colonizes the roots of plants, forming a protective barrier that prevents other harmful fungi from infecting them. Similarly, the bacterium *Pseudomonas fluorescens* produces antibiotics that inhibit the growth of pathogenic bacteria.

The use of pheromones is another type of biological control. Pheromones are chemical signals that insects use to communicate with each other, particularly during mating season. By releasing synthetic female sex pheromones, male insects become confused, reducing their ability to locate females for mating. This strategy can be particularly effective for controlling pests like codling moths in apple orchards. Codling moths are a significant pest in apple orchards, and their larvae can cause significant damage to apples. By disrupting their mating patterns, the use of pheromones can reduce the number of codling moths that produce offspring, thereby decreasing the overall population.

Biological control methods have several advantages over traditional pest management practices. One major advantage is that they are environmentally friendly. Unlike chemical pesticides, biological controls do not leave harmful residues in the soil or water. They also do not harm beneficial organisms like pollinators or natural enemies of pests. Biological controls also provide a sustainable solution to pest management by reducing the need for chemical inputs and promoting biodiversity in farming systems.

However, biological control methods also have some limitations. One limitation is that they may not be effective against all types of pests. Some pests may be resistant to certain predators or pathogens, making biological controls less effective. Another limitation is that biological controls may take longer to achieve results than chemical pesticides. Biological controls work by building up populations of natural enemies over time, which requires patience and persistence from farmers.

Furthermore, biological controls require careful monitoring and management to be successful. The release of predator insects or the application of microorganisms must be timed correctly to coincide with the pest's life cycle. Failure to do so could result in ineffective control or even exacerbate the problem by creating an imbalance in the ecosystem.

In conclusion, biological control methods are an important tool for managing pests in agriculture. By harnessing the power of nature, farmers can reduce the use of chemical pesticides and promote sustainable farming practices. While biological controls have limitations, they provide a safer and more environmentally friendly alternative to traditional pest management practices. To be successful, biological controls require careful planning, monitoring, and management to ensure that they are effective and sustainable.

Alternative Chemical Agents. While synthetic pesticides are not allowed in organic farming, there are alternative chemical agents that can be used to control pests. These agents are derived from natural sources and are often less toxic than their synthetic counterparts. For example, pyrethrins, which are extracted from chrysanthemum flowers, can be used to control aphids and other soft-bodied insects. Spinosad, a product of fermentation, is another alternative insecticide that targets caterpillars and thrips.

Essential oils are also used as insecticides in organic farming. Oils such as neem, peppermint, and thyme can repel or kill pests while leaving beneficial insects unharmed. However, care must be taken when

using essential oils as they can also harm pollinators if applied incorrectly. Organic farming prohibits the use of synthetic pesticides, which can cause harm to the environment and human health. However, there are alternative chemical agents that can be used to control pests in organic farming. These agents are derived from natural sources and are often less toxic than their synthetic counterparts.

One example of an alternative chemical agent is pyrethrin, which is extracted from chrysanthemum flowers. Pyrethrins are used to control aphids and other soft-bodied insects. They work by attacking the nervous system of the insect, causing paralysis and death. Pyrethrins break down rapidly in sunlight and do not persist in the environment, making them a safer option than synthetic pesticides. However, they can still be harmful to beneficial insects such as bees and ladybugs if not applied correctly.

Spinosad is another alternative insecticide that targets caterpillars and thrips. Spinosad is derived from fermentation and is effective against a range of pests, including leafminers, fruit flies, and spider mites. Spinosad works by affecting the insect's nervous system, leading to paralysis and death. Spinosad is considered safe for use in organic farming as it has low toxicity to mammals and breaks down quickly in the environment.

Essential oils are also used as insecticides in organic farming. Oils such as neem, peppermint, and thyme can repel or kill pests while leaving beneficial insects unharmed. Neem oil, for instance, is derived from the neem tree and is used to control a range of pests, including aphids, mites, and scale insects. Peppermint oil is effective against ants, fleas, and cockroaches, while thyme oil is used to control mosquitoes and ticks.

However, care must be taken when using essential oils as they can also harm pollinators if applied incorrectly. Essential oils can also be toxic to humans in high concentrations, so it is important to follow safety guidelines when using them. Essential oils should be diluted before use and applied only in the recommended amounts.

Another alternative chemical agent used in organic farming is diatomaceous earth. Diatomaceous earth is a powder made from the fossilized remains of diatoms, a type of algae. The powder is abrasive and works by physically damaging the exoskeletons of insects, causing them to dehydrate and die. Diatomaceous earth is effective against a range of pests, including ants, slugs, and cockroaches.

In addition to these alternative chemical agents, there are several other methods used in organic farming to control pests. These include cultural practices like crop rotation and inter-cropping, biological controls like predator insects and microorganisms, and physical controls like traps and barriers.

Crop rotation involves alternating the crops grown on a particular field over time to disrupt pest populations and prevent nutrient depletion. Inter-cropping involves planting different crops together in the same field to create a diverse habitat for beneficial insects. Biological controls involve using natural predators, parasites, or pathogens to control pests. Physical controls involve using traps, barriers, or other mechanical means to prevent pests from accessing crops.

In conclusion, there are several alternative chemical agents that can be used to control pests in organic farming. These agents are derived from natural sources and are often less toxic than their synthetic counterparts. However, care must be taken when using these agents as they can still harm beneficial insects if applied incorrectly. Organic farmers also rely on other methods like cultural practices, biological controls, and physical controls to manage pests safely and sustainably.

4. Conclusions

Organic farming is an important agricultural system that emphasizes sustainable practices and environmental stewardship. Integrated pest

management is a critical component of organic farming, and relies on the use of cultural practices, biological controls, and alternative chemical agents to prevent, monitor, and control pests. By using these strategies, organic farmers can produce healthy crops while minimizing the use of synthetic inputs. However, there is still much research to be done in order to fully understand the complex relationships between pests, beneficial organisms, and the environment. As such, ongoing efforts are needed to develop and refine integrated pest management strategies that are effective, safe, and sustainable for organic agriculture conditions.

5. Acknowledgements

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