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Review Article

ROLE OF INTEGRATED PEST MANAGEMENT IN AGRICULTURE

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ABSTRACT

Agriculture in India has a pivotal role in promoting food security, livelihoods and sustainable development, especially for the rural poor. However, it is increasingly affected by issues such as degradation of natural resources, increased frequency of extreme weather events and change in rainfall patterns that are linked to climate change. The population is also growing fast, affecting the demand for food and other agricultural products. Due to these factors and given the limited availability of agricultural land, the burden on the farming sector has increased manifold. The various crop plants are greatly affected by multifarious types of pests which not only result in reduced productivity figures but also distress the farmers as they get less revenue due to crop losses to these pests. Pest attack coupled with disease breakout sometimes results in suicidal situations as has been witnessed in our country. As such strong measures have to be taken up for bringing the pest attack to halt forthwith and reduce the incidence of pests. According to estimates by the Food and Agriculture Organization of the United Nations (FAO), East Asia (including China) and South Asia together account for more than half of pesticide use in developing countries in the world. Moreover, farmers often apply large quantities of highly toxic pesticide or even use banned or spurious ones, instead of less toxic alternatives. In order to overcome these negative effects Integrated Pest Management (IPM) offers an alternative that is safer for human and environmental health. Integrated pest management (IPM), also known as integrated pest control (IPC) is a broad-based approach that integrates practices for economic control of pests. IPM is the best combination of cultural, biological and chemical measures to manage diseases, insects, weeds and other pests. As the global population is on the rise the demand of growing world population for food and fiber require farmers to produce more crops on existing farm land. IPM is a big part of the solution. Increasingly it is being adopted in both developed and developing countries for long-term, sustainable agriculture that achieves adequate, safe and quality food production. IPM does not, however, consist of any absolute or rigid criteria. As it is a flexible system that makes good use of local resources and the latest research, technology, knowledge and experience. The main of the IPM aims to suppress pest populations below the economic injury level (EIL).

Keywords: Agriculture, Frequency, FAO, IPM, IPC.

INTRODUCTION

Agriculture in India has a pivotal role in promoting food security, livelihoods and sustainable development, especially for the rural poor. However, it is increasingly affected by issues such as degradation of natural resources, increased frequency of extreme weather events and change in rainfall patterns that are linked to climate change. The population is also growing fast, affecting the demand for food and other agricultural products. Due to these factors and given the limited availability of agricultural land, the burden on the farming sector has increased manifold. A negative consequence of this has been the over-exploitation of water resources, soil erosion and salinization, and desertification, compromising the sustainability of production systems. Angon *et al.*(2023).According to estimates by the Food and Agriculture Organization of the United Nations (FAO), East Asia (including China) and South Asia together account for more than half of pesticide use in developing countries in the world. Moreover, farmers often apply large quantities of highly toxic pesticide or even use banned or spurious ones, instead of less toxic alternatives. In order to overcome these negative effects Integrated Pest Management (IPM) offers an

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alternative that is safer for human and environmental health.

Pests

In layman's terms pest is the organism that disturbs the human life. Scientific definition of pest is that pests are those organisms which damage our cultivated plants, forests, storage; domestic products etc including other aesthetic qualities are called pests. The pests are those organisms which harbor in cultivated crops that reduce quality and quantity of crops.

Loss due to pests

Insect pests, diseases and weeds are the major constraints limiting agricultural productivity growth. Emerging problems of insecticide resistance, secondary pest outbreak and resurgence further add to the cost of plant protection. Annual crop losses due to insect pests and diseases in India are estimated to be 18 percent of the agricultural output. However, losses caused by specific pests may be higher. Also, new pests have appeared due to the changes in the cropping patterns and the intensive agricultural practices.

Factors responsible for pest outbreak

Pest population like all animal population are governed by their innate capacity to increase influenced by various factors including biotic and abiotic. Monoculture**,** Favorable conditions**,** Extension of cultivated areas**,** Accidental introduction**,** Intensive cultivation.

Monoculture

Monoculture refers to the agricultural practice of growing a single type of crop in a specific area. In monoculture, large expanses of land are devoted to cultivating a single species of plant. While this approach can lead to increased efficiency in terms of cultivation and harvesting, it also comes with certain risks such as increased susceptibility to pests and diseases, as well as soil degradation.

Favorable conditions

Favorable conditions in agriculture refer to the specific environmental and climatic factors that are conducive to the growth and development of crops. These conditions include appropriate temperature, adequate rainfall or irrigation, suitable soil composition, and the absence of extreme weather events.

Extension of cultivated areas

This phrase denotes the expansion or enlargement of areas dedicated to agriculture. It could refer to the process of clearing new land for farming, converting natural ecosystems into cultivated fields or simply increasing the acreage under cultivation.

Accidental introduction

Accidental introduction refers to the unintentional introduction of a species, often plants or animals, into a new environment. This can occur through human activities, such as global trade and travel, where organisms are transported to areas where they are not native. Sometimes, these introduced species can become invasive and disrupt local ecosystems.

Intensive cultivation

Intensive cultivation is an agricultural practice characterized by the use of high inputs of labor, capital, and technology relative to the land area being cultivated. This approach aims to maximize yields per unit of land and often involves the use of fertilizers, pesticides, and advanced irrigation techniques to boost productivity.

What is IPM

According to the Food and Agriculture Organization (FAO) of the United Nations IPM means considering all available pest control techniques and other measures that discourage the development of pest populations, while minimizing risks to human health and the environment. Integrated pest management (IPM), also known as integrated pest control (IPC) is a broad-based approach that integrates practices for economic control of pests.IPM is the best combination of cultural, biological and chemical measures to manage diseases, insects, weeds and other pests.

Why is IPM important

As the global population is on the rise the demand of growing world population for food and fiber require farmers to produce more crops on existing farm land. To increase these yields requires continuous improvement of agricultural technologies to minimize crop loss. The challenge is to do this while protecting the environment. IPM is a big part of the solution. Increasingly it is being adopted in both developed and developing countries for long-term, sustainable agriculture that achieves adequate, safe and quality food production. It improves farmer livelihoods and conserves non renewable resources. IPM does not, however, consist of any absolute or rigid criteria. As it is a flexible system that makes good use of local resources and the latest research, technology, knowledge and experience. The main of the IPM aims to suppress pest populations below the economic injury level (EIL).

Components of IPM

Planning is at the heart of an IPM program. Every crop has pests that need to be considered. If you wait until problems arise during a growing season, you will end up relying on pesticides more and more. A good integrated pest management program has three components a) Identifying and monitoring pest problems. b) Selecting the best pest management tactics. c) Record keeping and evaluating the program. By considering each of these components, applicators can set up an IPM program for insects, plant diseases, weeds and vertebrate pests.

a) Identifying and Monitoring Pest Problems:

Identifying Pest Problems

The first step in integrated pest management (IPM) is to identify and understand the specific pest problems affecting a given area or crop. This involves recognizing the types of pests present, their life cycles, and the extent of the damage they may cause.

Monitoring Pest Populations

Regular monitoring involves systematically checking for the presence and abundance of pests in the field. This can be done through various methods such as visual inspections, traps, pheromone monitoring, and other surveillance techniques. Monitoring helps determine if pest populations are reaching levels that require intervention.

Why it's Important

Early detection of pests allows for timely and targeted action, preventing the pests from causing significant damage. Understanding the specific pest issues also guides the selection of appropriate pest management strategies.

b) Selecting the Best Pest Management Tactics

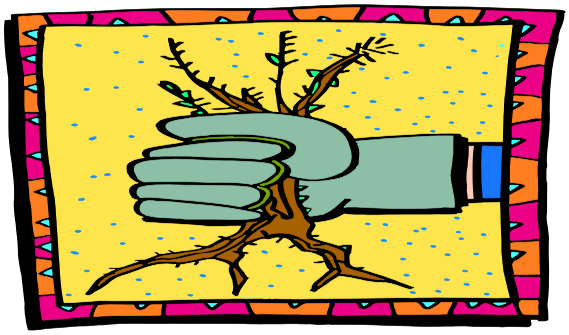
Assessing Pest Management Tactics

Once pests are identified and their populations are monitored, the next step is to select the most effective and sustainable pest management tactics. These tactics can include biological controls (using natural enemies), cultural practices (crop rotation, proper irrigation), mechanical controls (using traps or barriers), and chemical controls (judicious use of pesticides).

Considering Integrated Approaches

Integrated pest management involves combining multiple tactics to create a holistic and effective approach. The choice of tactics depends on factors such as the type of pest, the stage of the pest's life cycle, and the environmental impact of the control measures.

Cultural method



Mechanical method

Biological Method

Why it's Important

By selecting the most appropriate and least harmful tactics, the goal is to achieve effective pest control while minimizing negative impacts on the environment and non-target organisms. This approach is more sustainable in the long term.

c) Record Keeping and Evaluating the Program:

Record Keeping

Maintaining detailed records of pest monitoring activities, the types of pest management tactics applied, and the outcomes of these interventions. This includes information on the timing and frequency of treatments, as well as any changes in pest populations.

Evaluating the Program

Regularly assessing the success and effectiveness of the implemented pest management program. This involves comparing the outcomes with the goals set for pest control and overall crop health.

Why it's Important

Record keeping provides valuable data for assessing the efficacy of pest management strategies over time. It helps

in identifying trends, understanding the impact of interventions and making informed decisions for future pest management plans. Evaluation ensures that the IPM program remains adaptive and responsive to changing pest dynamics.

Principles of IPM

Use of resistant/tolerant cultivars and standard/certified seed and planting material. Harmful organisms must be monitored by adequate methods and tools, where available. Based on the results of the monitoring, the professional user has to decide whether and when to apply plant protection measures. Sustainable biological, physical and other non-chemical methods must be preferred to chemical methods if they provide satisfactory pest control. The pesticides applied shall be as specific as possible for the target and shall have the least side effects on human health, non-target organisms and the environment. The use of pesticides should be kept to the minimum levels that are necessary. Available anti-resistance strategies should be applied to maintain the effectiveness of the products. Check the success of the applied plant protection measures.

Methods of IPM

The primary control methods used in IPM are: Cultural, Mechanical, Physical, Biological, Chemical some control methods may also kill off potential predators of the pest and intensify the pest problem.

Cultural method

These controls are modifications of normal facility orplant care activities that reduce or avoid pest problems. These include landscape maintenance such as proper fertilizing and watering. Cadoux *et al.* (2015) eliminating pounding for potential mosquitoes and reducing trash for insects and vectors are also examples of cultural controls.

Mechanical method

These controls involve labor, not including the application of chemical pesticidesControlling weeds by hand-pulling, weed eaters or mulching are examples. Application of sticky traps, bird netting and hand-picking insects are all mechanical controls.

Physical method

These controls are environmental manipulations that indirectly control or prevent pests by altering temperature, light or humidity. The addition of the product Aqua shade to a pond darkens a pond and limits the amount of sunlight needed for algae growth. Certain foliar diseases are controlled by thinning the plant canopy, which improves air circulation and reduces humidity. The use of diluted white latex paint applied to trees to reduce sun scald is also a physical control.

Biological method

These control methods use beneficial organisms to control unwanted organisms.The introduction of lady beetles to a garden area or beneficial nematodes to a lawn are examples of biological control.Hajek and J. Eilenberg (2018).

Chemical method

Pesticides include insecticides (for insects), fungicides (for fungi), rodenticides (for rodents), aviacides (for birds) and herbicides (for weeds). All pesticides fall into one of the three classes: Class I is Danger, Class II is Warning, and Class III is Caution. If a pesticide is warranted, use the least toxic pesticide to be effective in controlling the pest. Bueno *et al.* (2011).

Genetic control

Plant resistance to insect pests can sometimes be achieved by transferring genetic material from certain insects-destroying micro-organisms to hybrid seeds. Genetic

control has been widely used in the past and offers great promise for the future, especially when combined with new gene-manipulation techniques.Han *et al.* (2018).

Educating others

All facility occupants should understand the basic concepts of IPM and who to contact with questions or problems. Educating the staff has several benefits: All personnel can be useful in monitoring for specific pests and reporting their presence to staff pest control personnel. All personnel are also helpful in reporting the efficacy of a particular control method.

Process of education

Benefits of IPM

Improved crop profitability due to better pest control measures and appropriate use of crop protection products. It helps in decreased severity of pest infestations. Reduced potential for problems of pest resistance or resurgence. Increased consumer confidence in the safety and quality of food and fiber products. Crop protection companies that integrate IPM principles into marketing and customer support for their products also stand to benefit from: Sustained market share and access, less risk of restrictions or deregistration, new opportunities for established and novel product, techniques and services, longer product lifecycle, decreased resistance of pests to crop protection products and biotech plants and increased public confidence and credibility of the crop protection industry.

Limitations of IPM

Complexity and Expertise: Implementing IPM requires a good understanding of the pests, their life cycles, and the ecosystem. Farmers and pest control professionals need to have the knowledge and skills to monitor and assess the pest populations accurately. This complexity may be a limitation for those without the necessary expertise. Cost: Some of the methods used in IPM, such as biological control agents or pheromone traps, can be more expensive than conventional chemical pesticides. While the long-term benefits may outweigh the costs, the initial investment may be a barrier for some farmers, especially those in low-income regions. Time-Consuming: IPM often involves multiple strategies and may take longer to show results compared to chemical pesticides. Farmers may need to invest more time in monitoring, implementing control measures, and waiting for the natural processes to take effect. Resistance Management: In some cases, pests may develop resistance to the control methods used in IPM, just as they can with chemical pesticides. This could reduce the effectiveness of certain strategies over time and necessitate the development of new approaches. Weather Dependence: The effectiveness of certain IPM strategies, such as the introduction of natural predators or the use of biopesticides can be influenced by weather conditions. Adverse weather may limit the success of these methods. Lack of Market Incentives: In some agricultural systems, there may be a lack of market incentives for farmers to adopt IPM practices. If consumers are not willing to pay more for products produced using IPM, farmers may be less motivated to invest in these methods. Limited Availability of Biological Controls: The success of biological control methods, such as introducing predators or parasites, depends on the availability of suitable organisms. In some cases, it may be challenging to find or mass-produce these biological control agents. Education and Awareness: Farmers need to be educated about IPM principles and practices for successful implementation. Lack of awareness or resistance to change can hinder the adoption of IPM. Source:S. K. Dara (2019).

Constraints in Implementation of IPM

According to Koul*et al.*(2004),an in-depth study has categorized constraints to the implementation of IPM in developing countries into the following five main groups:-

1) **Institutional constraints**

a) IPM requires an interdisciplinary, multifunctional approach. Traditional top down research, in many cases does not address the real needs of farmers who are the end

users and either adopt or reject the technology based on its appropriateness.

b) Institutional barriers to on farm research by national research scientists in developing countries need to be addressed.

2) **Information constraints**

The lack of IPM information that can be used by farmers and extension workers is a major constraint as is the lack of training material, curricula and experienced IPM teachers.In many cases, field-level extension workers are no sufficiently trained in IPM to instill confidence in farmers.

3) Sociological constraints

Often, farmers and farm-level extension workers become conditioned to advocate the use of chemicals as being simple and highly effective. This is a major constraint in IPM implementation. Private industry and public sector extension agencies need to complement each other's efforts to overcome this constraint.

4) Economic constraints

Funding for research, extension and farmer training in IPM is often inadequate, limiting IPM adoption.

5) Political constraints

In some cases, government subsidies for pesticides and their linkage with government-provided credit for crop production are an important constraint to farmer acceptance of IPM.

IPM Guidelines

IPM Guidelines that are helpful in designing a program: Preventative measures should be explored early. No control method is to be taken until/unless a problem is observed and verified. The problem must exceed the "acceptable level of damage". Evaluate available alternative methods of control. Select the method that is most effective/cost-effective and has the lowest impact on the environment. Time control action for effectiveness and safety. Follow-up and monitor results, keep records. Evaluate and modify the program as necessary.

IPM practices in sericulture

In sericulture cocoon production involves two distinct activities namely, mulberry leaf production, which is the sole feed for silkworm and silkworm rearing. Both mulberry and silkworm are infested with a number of pests, which effect the cocoon quality and productivity resulting in economic loss to the farmers. Chemical control measures of pests is widely adopted by the farmers and its hazardous effects on human health and beneficial organisms are the least considered. Therefore IPM techniques mainly involving suitable biological measures have been evolved and popularized for the control of mulberry and silkworm pests. However, despite the favorable results, the adoption level has remained low. It has been said that there was the highest technological gap(87.60%) in the adoption of biological control measures against the mulberry pest whereas the gap with cultural/ mechanical practices was 33.30% and minimum 9.80% in the adoption of chemical measures. In case of management of Uzi menace on silkworm, there was no technological gap with respect to mechanical method of using Nylon net to prevent the entry of Uzi fly inside the rearing house, whereas the technological gap of 77.00% and 71.50% was observed for biological and chemical control method respectively. Thus, the IPM practices with the special emphasis on biocontrol method needs to be popularized among the farmers by intensified extension efforts for wider adoption at the farmer's level.

CONCLUSION

As of now we have been witness to fact that pest attack heavily results in crop losses. As such strategy has to be developed to mitigate the attack which can be done by taking up some measures including: Crop rotation is very important step to reduce the pests which are lured by a particular crop variety. Prophylactic measures have to be in place to reduce the pest attack.Integrated approach through the use of various components of pest management shall have to be taken up in hand. This would not only reduce the use of chemicals but would also render the IPM approach economical and ecofriendly. A proper calendar of visiting pests shall have to be developed just to have a fair idea as to which pest visits the crop and when. This would enable us to work out effective and strategic control for pests.

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