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STUDIES ON ROLE OF BIO-CONTROL STRATEGIES FOR VEGETABLE CROPS

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ABSTRACT

Vegetable crops are crucial to the world's food security and are susceptible to a number of pests and illnesses that can significantly impair yields and quality. Traditional pesticide-based strategies have been widely employed to address these issues, but their abuse has led to worries about environmental pollution, risks to human health, and the emergence of pesticide resistance. In recent years, eco-friendly and sustainable methods for managing pests and diseases in vegetable crops have evolved, including biocontrol techniques. This study seeks to offer a thorough overview of the function of biocontrol techniques in the production of vegetable crops, covering the many types of biocontrol agents, their mechanisms of action, and their efficacy in managing pests and diseases. This paper also covers the difficulties and potential of biocontrol techniques in the development of sustainable vegetable crops.

KEYWORDS: Insect pests, Vegetable crops, Biological Control, Eco-friendly management.

I. INTRODUCTION

Due to the fact that vegetables offer necessary nutrients and support a balanced diet, vegetable crops are crucial for ensuring the world's food security. The great susceptibility of these crops to different pests and diseases, however, can result in large output losses and a deterioration in crop quality. Chemical pesticides are the mainstay of conventional pest management techniques, but their overuse has led to worries about environmental contamination, risks to human health, and the emergence of pesticide resistance. In recent years, eco-friendly and sustainable methods for managing pests and diseases in vegetable crops have evolved, including biocontrol techniques. These methods employ helpful microbes and natural enemies to control pests and illnesses while reducing the detrimental effects on the environment and human health.

In accordance with their characteristics and modes of operation, biocontrol agents can be categorised into a variety of groups. In the development of vegetable crops, microbial biocontrol agents including bacteria, fungus, viruses, and nematodes are frequently employed. Through competition, parasitism, pathogenicity, and predation, these microorganisms can directly combat infections and pests. While specialised fungi, such as *Beauveria bassiana* and *Metarhizium anisopliae*, infect and kill insect pests, certain strains of *Bacillus thuringiensis* (Bt) generate insecticidal proteins that are harmful to particular insect pests. Additionally, by preying on or parasitizing pest populations, beneficial insects like ladybirds, lacewings, and parasitoids play a critical role in regulating pest population. Additionally effective biocontrol agents against a variety of pests include predatory mites and entomo-pathogenic nematodes.

II. Vegetable crops' main insect pests and the amount of their damage in India

Vegetable crops are plagued by a variety of insect pests over the course of their growth and development. Vegetables face significant obstacles from them both on and off the pitch. Depending on their eating habits, they might destroy property in different ways. In addition to causing direct harm, they also serve as persistent, semi-persistent, and non-persistent vectors for a variety of viral illness. At various crop growth phases, 30–40% of crop losses were calculated by various studies. The main causes of a pest outbreak and epidemics include changes in farming practices, such as intensive mono-cropping and the introduction of high yielding but vulnerable types and hybrids that require high inputs. Due to the change in seasons and suitable climatic circumstances, tiny pests have occasionally become severe problems. Shoot and fruit borers, which cause destructive signs including wilted terminal shoots, drill holes in stems, and fill up with faeces, are the main pests attacking plants.

III. Need for Biological Pest Control

Beyond the good productivity and production of agricultural and horticultural products, farmers frequently deal with a variety of issues, such as the excessive use of inputs, particularly chemical fertilisers and nutrients to acquire good yields, as well as the management of different insect pests and illness. This has resulted in high cultivation and investment costs,

which will be reflected in yield and measurable returns. Contrarily, chemical fertilisers and pesticides have polluted the environment and harmed both human and animal life. Due to this, farmers' attitudes towards the usage of pesticides and their transition to alternative, environmentally friendly practices have undergone significant adjustments.

Biological Control Agents

In India, chemical pesticides constitute the mainstay of plant protection techniques. Pesticides are being used by the farmers, therefore the application is time-based. Due to the high value of vegetable crops, even a tiny infestation might result in quality loss and decreased monetory returns. Insecticides are therefore being sprayed by farms regularly even when the pest level is below ETL. Vegetable producers have been doing this for a while now and it has become customary.

Table 1: Major insect pests affects vegetable crops in India.

Sl No	Pest	Crop infested	Parts damaged	Extent of damage
1	Fruit borer (*Helicoverpa armigera*)	Tomato	Fruits	24-73%
2	Fruit and shoot borer (*L. arbonalis*)	Brinjal	Shoot and fruits	11-93%
3	Thrips (*S. dorsalis*)	Chilli	Leaves and fruits	12-90%
	Mites (*Polyphagotarsonemus latus* (Banks))		Leaves and fruits	34%
4.	Fruit borer (*Helicoverpa armigera*)	Bhendi/Okra	Fruits	22%
	Leafhopper (*A. bigutella bigutella*)		Leaves	54-66%
	Whitefly (*B. tabaci*)		Leaves	54%
	Shoot and fruit borer (*E. vittella*)		Shoot and fruits	23-54%
5.	Diamond back moth (*P xylostella*)	Cabbage	Head	17-99%
	Cabbage caterpillar (*P brassicae*)		Leaf and head	69%
	Cabbage leafwebber (*Crocidolomia binotalis*)		Leaves	28-51%
	Cabbage borer (*H. undalis*)		Head	30-58%
	Cabbage Butterfly (*Pieris rapae/brassicae)*		Head	40-68.5%
6.	Fruit fly (*B. cucurbitae*)	Cucurbits (Cucumber, Ivy gourd, Musk melon, Snake gourd, Sponge gourd)	Fruits	20-100%
7	Aphid (*Myzus persicae* (Sulzer))	Potato	Leaves	3-6%
	Tobacco caterpillar (*S. litura*)		Leaves	4-8%
	Potato tubermoth (*Phthorimaea operculelella* (Zeller))		Tubers	6-9%
	Mite (*P.latus*)		Leaves	4-27%

Different methods can be used to implement biocontrol tactics. IPM is an all-encompassing strategy that integrates several pest control methods, including as biocontrol, cultural practises, and the sparing use of pesticides. By giving natural adversaries adequate habitats, nectar supplies, and shelter, conservation biological management seeks to increase the populations of these pests. In order to suppress pests, augmentation biological control entails the widespread distribution of biocontrol agents. To quickly eradicate pests, inundative biological control concentrates on flooding the target area with large concentrations of biocontrol agents.

Microbial Biocontrol Agents

Similar to plant pathogens, these microorganisms—fungi, bacteria, protozoa, viruses, actinomycetes, and nematodes—attack and eliminate insect pests. Innudative application can be followed by the formulation of insect-pathogenic fungi (*Metarhizium, Beauveria*, *Paecilomyces*), insect-pathogenic bacteria (*Bacillus thuringiensis*-Bt), entamo-pathogenic nematodes (*Heterorhabditis* and *Steinernema*), and viruses Granulosis virus (GV) and nuclear polyhedrosis virus-NPV). The 12 classes of the six phyla of the main groupings like Laboulbeniales, Pyrenomycetes, Hyphomycetes, and Zygomycetes make up the fungal biocontrol agents. Many of the potential biocontrol medicines have already found widespread commercial success.

Numerous research have shown that biocontrol techniques are beneficial in the development of vegetable crops. According to several case studies, the use of biocontrol chemicals successfully decreased insect populations and increased agricultural productivity. In certain cases, biocontrol methods have been demonstrated to be on par with or even better than chemical pesticides. Furthermore, by protecting beneficial insects, lowering chemical residues, and preventing the emergence of pesticide resistance, the use of biocontrol agents can support sustainable agriculture.

Insecticide usage has expanded as a result of the extensive growth of vegetable crops, particularly in the proximity of cities and towns, in an effort to control crop-ravaging pests. However, in recent years there has been a greater interest in biological pest control due to the ineffective management of some pests by pesticides. The major causes of this were the ineffectiveness of the pesticides or the pests' development of resistance.

IV. Developing bio pesticides from biocontrol agents

The use of chemical pesticides in agriculture must be drastically reduced, and sustainable biocontrol methods must be promoted. Because of their ecological benefits, the use of biological control agents or insect bio-pesticides has attracted growing interest (Roger, 2012). However, because we lack an adequate regulatory framework for their registration, marketing, and use, their commercialization is very behind.

An active biological control approach (inundative release) rather than a passive one (classical or inoculative release) should be used to address this issue, particularly with regard to short-duration crops. This is due to the fact that insect activity is only ever seen in short-lived crops, such vegetables. On the natural adversaries of vegetable crop pests, very little is known. The goal of the current study is to raise awareness of the biological management of a few vegetable crops by utilising their natural enemies. The broad use of biocontrol techniques has obstacles and constraints, nevertheless. Farmers may encounter obstacles due to the commercial viability and affordability of biocontrol chemicals, especially in poor nations. To guarantee their effectiveness and quality, biocontrol products need to be standardised and regulated. Farmers may need to make modifications and go through a learning curve in order to integrate biocontrol technologies with conventional methods and crop production systems. For farmers and other stakeholders to understand and embrace biocontrol measures, effective communication, awareness, and training programmes are crucial.

V. Future Possibilities & Scope

Future possibilities for biocontrol techniques in the cultivation of vegetable crops are bright. More effective and targeted biocontrol agents may be created as a result of developments in biotechnology and microbiological research. The efficiency and simplicity of biocontrol tactics can be increased by combining them with contemporary technology like precision agriculture, remote sensing, and molecular tools. Programmes for education and training can provide farmers with the information and abilities they need to successfully use biocontrol measures. In order to provide a favourable environment for the implementation of biocontrol techniques in agriculture, policy support and regulation are also essential.

VII. CONCLUSION

The review study offers a thorough examination of the function of biocontrol tactics for vegetable crops, showing their efficiency in managing pests and diseases. It emphasises the requirement for environmentally friendly alternatives to get beyond the drawbacks of traditional pesticide-based techniques. This review intends to encourage more study and encourage the implementation of biocontrol technologies in vegetable crop production, contributing to global food security and environmental sustainability. It does this by providing case studies and analysing future prospects.

For managing pests and diseases in vegetable crops, biocontrol techniques provide environmentally responsible and sustainable solutions. Biocontrol techniques can efficiently reduce pests and illnesses while minimising the negative effects associated with conventional pesticides by using the strength of natural enemies and beneficial microorganisms. The potential advantages of biocontrol technologies in the development of vegetable crops are significant, notwithstanding certain obstacles. Realising the full potential of biocontrol techniques and guaranteeing a sustainable and resilient future for vegetable crop production depend on ongoing research, technical improvements, and support from policymakers and stakeholders. The most efficient and environmentally friendly method of managing pests in vegetable crops is typically regarded as biological control. As an alternative to chemical pesticides, the conservation of natural enemies, predators, parasitoids, and microbial bio-control agents can be sustained. Biological control should be a part of integrated pest management even if it won't completely eradicate all insects at once.

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