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Integrated Disease Management of Powdery Mildew in Cucurbits Using Bioagents and Botanicals

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Abstract

Powdery mildew is one of the most destructive foliar diseases of cucurbit crops worldwide, significantly reducing yield and fruit quality under both open-field and protected cultivation systems. The disease is primarily caused by Podosphaera xanthii and Erysiphe cichoracearum, which thrive under warm and dry environmental conditions commonly observed in tropical and subtropical regions. Excessive reliance on chemical fungicides has led to issues such as resistance development, environmental contamination, and residue accumulation on produce. Therefore, integrated disease management (IDM) strategies incorporating bioagents and botanicals offer sustainable and eco-friendly alternatives. This review discusses the etiology, epidemiology, and integrated management of powdery mildew in cucurbits, with special emphasis on biological control agents and plant-derived products as viable components of sustainable disease management.

Keywords: *Powdery mildew, cucurbits, integrated disease management, bioagents, botanicals, Trichoderma, Bacillus, plant extracts.*

Introduction

Cucurbits, belonging to the family Cucurbitaceae, include economically important crops such as cucumber, melon, pumpkin, bottle gourd, ridge gourd, bitter gourd, and squash. These crops are widely cultivated for their nutritional, medicinal, and commercial value. However, cucurbit production is severely constrained by several fungal diseases, among which powdery mildew is one of the most prevalent and economically significant [1]. Powdery mildew can occur at all growth stages and affects leaves, stems, and sometimes fruits. The disease appears as white, powdery fungal growth on leaf surfaces, leading to chlorosis, premature leaf senescence, reduced photosynthetic activity, and poor fruit development. Yield losses may range from 20% to 50% and can reach higher levels under favorable environmental conditions [2]. Unlike many fungal pathogens, powdery mildew fungi do not require free water for infection, making them particularly problematic in dry climates and greenhouse cultivation. Conventional management largely depends on repeated fungicide applications. However, increasing concerns regarding fungicide resistance, environmental safety, and consumer health have driven the need for alternative strategies. Integrated disease management (IDM) combining biological control agents, botanicals, cultural practices, and resistant varieties provides a sustainable approach to managing powdery mildew in cucurbits.

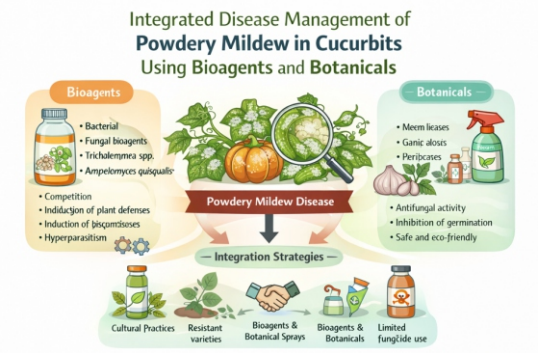

Fig 1: Disease management in cucurbits through bioagents

Etiology and Disease Development

Powdery mildew in cucurbits is mainly caused by the obligate biotrophic fungi *Podosphaera xanthii* and *Erysiphe cichoracearum*. These pathogens produce superficial mycelium and conidia on host surfaces, giving the characteristic powdery appearance. The fungi spread primarily through airborne conidia, enabling rapid dissemination across fields. Optimal conditions for disease development include temperatures between 20–30°C and moderate relative humidity [3]. The pathogen penetrates host epidermal cells using specialized structures called appressoria and establishes feeding structures known as haustoria to extract nutrients. Continuous cropping and protected cultivation environments further enhance disease persistence and severity.

Principles of Integrated Disease Management

Integrated disease management involves the combination of multiple compatible strategies to suppress disease below economic threshold levels while minimizing environmental impact. In powdery mildew management, IDM includes host resistance, cultural practices, biological control agents, botanicals, and need-based chemical applications [4]. Cultural practices such as proper spacing, removal of infected plant debris, balanced fertilization, and improved air circulation reduce disease incidence. However, the focus of sustainable IDM lies in the use of bioagents and botanicals.

Bioagents in the Management of Powdery Mildew

Biological control agents offer an environmentally safe alternative to chemical fungicides. Several antagonistic microorganisms have shown promising results against powdery mildew pathogens. Species of *Trichoderma* act through mechanisms such as competition, mycoparasitism, production of antifungal metabolites, and induction of systemic resistance in plants. Foliar sprays or soil applications of *Trichoderma harzianum* and *Trichoderma viride* have been reported to reduce disease severity in cucurbits. Bacterial bioagents such as *Bacillus subtilis* and *Pseudomonas fluorescens* suppress powdery mildew through antibiotic production, siderophore secretion, and activation of host defense responses [5]. These bacteria colonize the phyllosphere and inhibit pathogen establishment. Commercial formulations of *Bacillus* spp. are widely used in organic farming systems. Ampelomyces quisqualis, a hyperparasite of powdery mildew fungi, directly infects and destroys powdery mildew mycelium and spores. Its application significantly reduces spore viability and disease spread.

Botanicals in Powdery Mildew Management

Botanicals derived from plants possess antifungal properties and serve as effective alternatives to synthetic fungicides. Neem-based products containing azadirachtin exhibit antifungal and growth-inhibitory effects against powdery mildew pathogens. Garlic extract, clove oil, thyme oil, and eucalyptus oil have demonstrated inhibitory effects on spore germination and mycelial growth. Plant extracts such as those from neem (*Azadirachta indica*), tulsi (*Ocimum sanctum*), and lantana (*Lantana camara*) have been tested for their antifungal potential [6]. These botanicals act through multiple mechanisms, including disruption of fungal cell membranes and inhibition of enzymatic activity. Botanical sprays are biodegradable, eco-friendly, and compatible with biological control agents, making them suitable components of IDM programs.

Integration Strategies

For effective management, bioagents and botanicals should be integrated with cultural practices and resistant cultivars. Seed treatment with bioagents followed by periodic foliar application of botanical extracts can significantly reduce initial inoculum and disease progression. Alternating bioagent sprays with botanical formulations helps prevent pathogen resistance development [3].

In protected cultivation systems, combining environmental control measures such as adequate ventilation with biological and botanical treatments enhances disease suppression. Limited and need-based use of compatible fungicides may be included as part of resistance management strategies.

Advantages of Bioagents and Botanicals

The use of bioagents and botanicals offers several advantages, including reduced chemical residues, lower risk of resistance development, environmental safety, and compatibility with organic production systems. These approaches also promote soil health and biodiversity, contributing to sustainable agriculture.

Conclusion

Powdery mildew remains a major challenge in cucurbit production systems. Overreliance on chemical fungicides has led to resistance and environmental concerns, necessitating sustainable alternatives. Integrated disease management strategies incorporating bioagents and botanicals provide effective, eco-friendly, and economically viable solutions. The formulation improvement, field efficacy, and large-scale adoption will strengthen the role of biological and plant-based products in managing powdery mildew in cucurbits.

References

1. McGrath, M. T. (2001). Fungicide resistance in cucurbit powdery mildew: Experiences and challenges. *Plant Disease*, 85(3), 236–245. https://doi.org/10.1094/PDIS.2001.85.3.236
2. Pérez-García, A., Romero, D., Fernández-Ortuño, D., López-Ruiz, F., De Vicente, A., & Torés, J. A. (2009). The powdery mildew fungus *Podosphaera xanthii*: A constant threat to cucurbits. *Molecular Plant Pathology*, 10(2), 153–160. https://doi.org/10.1111/j.1364-3703.2008.00527.x
3. Kiss, L. (2003). A review of fungal antagonists of powdery mildews and their potential as biocontrol agents. *Pest Management Science*, 59(4), 475–483. https://doi.org/10.1002/ps.689
4. Elad, Y., & Pertot, I. (2014). Climate change impacts on plant pathogens and plant diseases. *Journal of Crop Improvement*, 28(1), 99–139. https://doi.org/10.1080/15427528.2014.865412
5. Dagostin, S., Schärer, H. J., Pertot, I., & Tamm, L. (2011). Are there alternatives to copper for controlling grapevine downy mildew in organic viticulture? (Relevant for botanical and biological approaches). *Crop Protection*, 30(7), 776–788. https://doi.org/10.1016/j.cropro.2011.02.031
6. Harman, G. E., Howell, C. R., Viterbo, A., Chet, I., & Lorito, M. (2004). *Trichoderma* species—Opportunistic, avirulent plant symbionts. *Nature Reviews Microbiology*, 2, 43–56. https://doi.org/10.1038/nrmicro797