



SUSTAINABLE BIOTECHNOLOGIES FOR NEXT-GENERATION PEST MANAGEMENT: A REVIEW OF ECO-FRIENDLY STRATEGIES

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Abstract: Modern agriculture requires sustainable alternatives to synthetic pesticides. This review highlights eco-friendly biotechnological strategies based on plant-derived compounds and signaling chemicals that interfere with insect behavior and reproduction. Emerging approaches integrating chemical ecology and precision agriculture demonstrate promising potential for effective pest control with reduced ecological impact.

• Introduction

- Intensive pesticide use threatens biodiversity, soil health, and human safety;
- Sustainable agriculture demands environmentally compatible pest management strategies;
- Natural bioactive compounds can disrupt insect communication and reproductive behavior;
- Behavioral pest control offers a minimally invasive alternative to conventional pesticides.

• Eco-Friendly biotechnological strategies

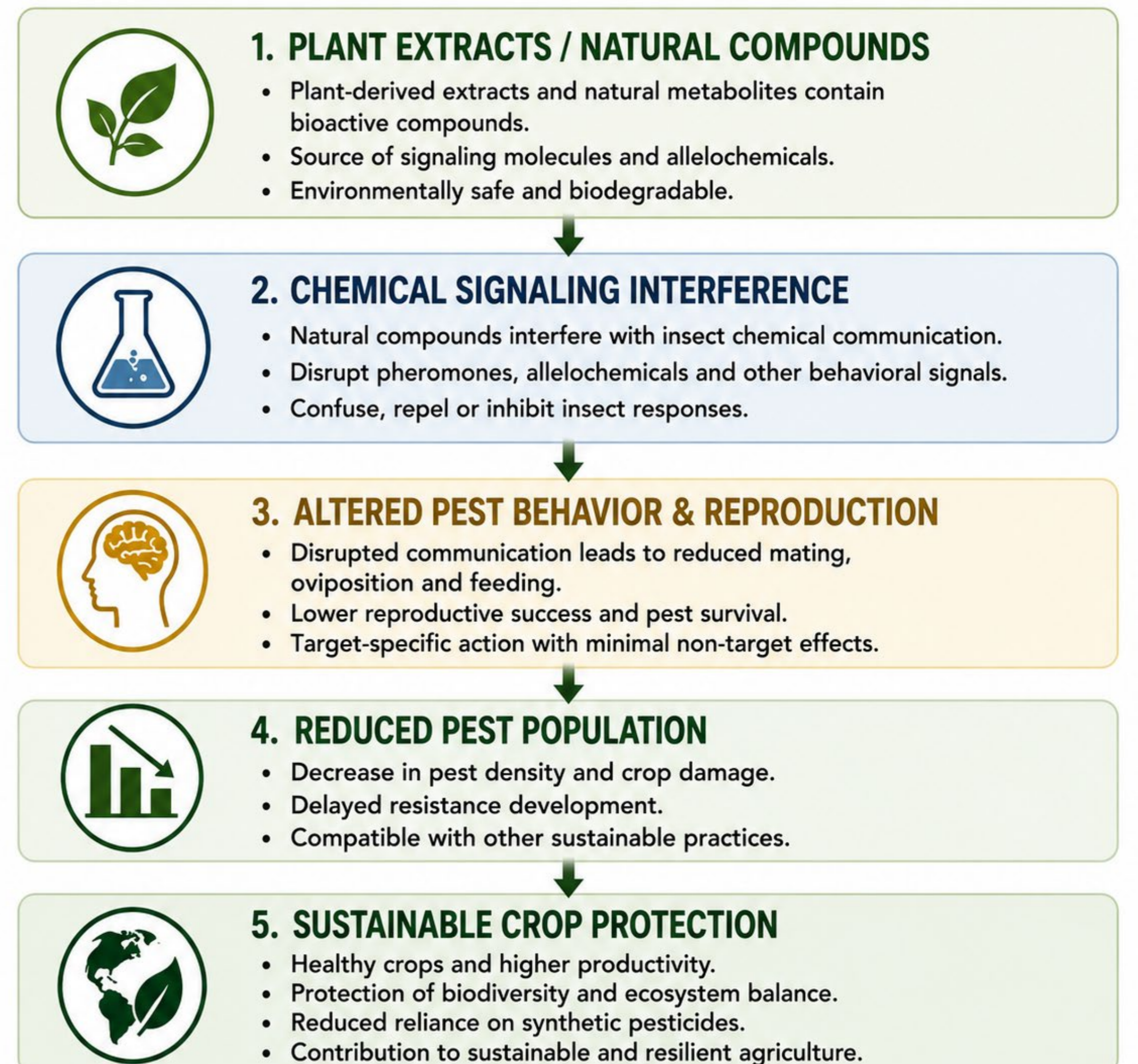
- Plant-Derived Bioactive Compounds:
 - Botanical extracts modify insect feeding and mating behavior;
 - Natural metabolites reduce pest adaptation and resistance;
 - Low toxicity toward non-target organisms.
- Biologically Mediated Behavioral Interference:
 - Pheromone disruption affects insect reproduction;
 - Allelochemicals alter host recognition and communication.
 - Species-specific targeting minimizes ecosystem disturbance.

• Integrated sustainable pest management

- Combines biotechnology, chemical ecology, and precision agriculture;
- Enhances crop resilience and environmental sustainability;
- Applicable in organic and regenerative agricultural systems.

Behavior-Based Sustainable Pest Management

From Natural Compounds to Sustainable Crop Protection



KEY BENEFITS



• Conclusions

- Sustainable biotechnologies represent a promising alternative to conventional pest control;
- Natural signaling interference can effectively regulate pest populations;
- Eco-friendly approaches support biodiversity conservation and long-term agricultural sustainability;
- Further field validation and interdisciplinary research remain essential.