Unveiling the secrets of multitrophic interactions: leading advancements in biological weed control

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Biological control is a key part of integrated weed management. Before using bio-agents, we need to better understand how multiple agents interact to control weeds. This includes knowing how plants respond to and prioritise different attackers. Terrestrial ecosystems worldwide have many species and interactions, including various trophic levels in the same food chain. Plants are crucial in mediating interactions between their microbes and insects. Changes in plants caused by one species can cascade, affecting other species' numbers and community structure. Studies show that using multiple agents is more effective than single-agent releases. Synthetic herbicides are being discouraged due to herbicide-resistant weeds and environmental concerns. Researchers are developing effective biological control agents for a wide range of weeds. Sustainable weed management requires biological methods like insect bio-agents, mycoherbicides and deleterious rhizobacteria. Cultural practices and allelochemicals, which are biological elements, contribute to sustainable agriculture. Therefore, biological agents are more effective at reducing weed damage than allowing weeds to grow unchecked. The challenge is to find suitable microbes/bio-agents that reduce weed growth.

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success story unfolded when the cactus moth (*Cactoblastis cactorum*), imported from Argentina, was released. This moth multiplied and decimated the prickly pear infestation within ten years, reducing its coverage to just 1% of its original distribution.

Above-ground insects, such as herbivores, their natural enemies, and pollinators, interact bidirectionally with beneficial microbes in the soil through the plant. The significance of these interactions in both agricultural and natural ecosystems is increasingly clear, requiring more focus on their underlying molecular and physiological mechanisms. The present review examines plant-mediated interactions between above-ground insects and beneficial below-ground microbes. Different soil microbes change plants, impacting pollinators, natural enemies, and insects that eat plants. Good microbes help herbivores by making plants grow better and stronger in their upper parts. Plants that release volatile organic compounds primarily attract beneficial insects.

Seeing how plants manage and prioritise their defences when attacked by different threats is fascinating. Terrestrial ecosystems are known for their vast array of species and the wide variety of ways these species interact, including those at different levels of the same food chain. Plants are crucial in managing how insects and microbes interact with each other when they are together. When one species changes a plant, it often creates a chain reaction, affecting how it interacts with other species. This then influences the types and number of organisms in those communities. Recent studies have shown that using multiple agents to combat