Computational Quantitative Optimization of Biodiverse Biological Control Systems for Sustainable Suppression of Sciaridae Using Steinernema feltiae

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The most common threat to agricultural settings is the infestation of insect pests, leading to the destruction of crops. Modern-day agricultural systems lack the intricate living systems that are found throughout all natural ecosystems, which provide checks and balances that ensure a functioning and sustainable ecosystem. As a result, this leads to outbreaks of disease and pests, which necessitate the use of harsh pesticides and chemicals that have detrimental effects on the environment. My study investigates whether biological controls for suppressing Sicaridae populations can be optimized through a constraint-based mathematical framework. Controlled enclosed systems of carnivorous plants (Drosera, Dionaea, Utricularia, Nepenthes, and Pinguicula) and Steinernema feltiae were introduced to Allium schoenoprasum, Allium cepa, and Capsicum annuum. The Drosera and Nepenthes demonstrated the capability to suppress the Sciaridae population to a high extent, as well as improved seedling survival, increased shoot height, and generated a deeper green pigmentation, indicating improved physical health compared to the control, which lacked the introduction of any carnivorous organisms. The carnivorous organism that demonstrated the strongest capability at suppressing the Sciaridae population was the Steinernema feltiae; it completely eradicated all Sciaridae populations, and there was zero seedling mortality, as well as demonstrating all the similar qualitative characteristics as the Drosera and Nepenthes group to a higher extent. With these findings in mind, I then developed a mathematical model dependent on the density of prey to predict predation rates in order to determine the minimal amount of Steinernema feltiae to fully suppress Sciaridae populations.

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