

Precision Irrigation: An Eco-Friendly Approach for Nematode Management

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Introduction

Plant-parasitic nematodes are microscopic, tiny roundworms that pose a significant threat to agricultural productivity worldwide, particularly in the warm, moist climates of the tropics and subtropics. Globally, the annual agricultural crop loss due to plant parasitic nematodes is more than \$80 billion. Root-knot nematode (*Meloidogyne incognita*) is the most economically important nematode with a very vast host range, starting from field crops, vegetables, fruit plants, flowering plants, ornamentals, etc. These nematodes dwell in the soil and damage the plant roots by penetrating them and causing a typical root-knot symptom, leading to stunted plant growth, chlorosis, reduced flowering, and fruiting. Traditional management practices by use of chemical nematicides are effective but raise environmental concerns. A ban on many chemicals has pushed growers to explore integrated and sustainable nematode management approaches. Precision irrigation and soil drainage design are gaining importance for their ability to manipulate soil moisture dynamics in a way unfavourable for nematode proliferation.

Nematodes and soil moisture dynamics

Nematodes require a thin film of moisture for their survival, movement, reproduction, and infection of host plants. The moist soil, when combined with warm temperatures, creates an ideal environment for nematode activity. Precision irrigation offers farmers the ability to deliver the right amount of water at the right time, minimizing favourable conditions for nematodes. Excessive irrigation creates waterlogged conditions, reducing root vigour and making the plants more susceptible to nematode attack. If there is deficit in irrigation, the plant will be in stress lowering their natural resistance. Optimized irrigation maintains soil moisture within a safe zone that supports plant growth but discourages nematode proliferation (Petrikovszki, 2024).

Techniques for precision irrigation in nematode management

- **Drip irrigation:** it limits the water distribution only to the root zone and reduce nematode spread through soil water movement from field to field (Zasada & Powell, 2002).

- **Soil moisture sensors:** These sensors can provide real time data, preventing over irrigation that favours nematodes.
- **Irrigation scheduling:** if the irrigation time match to the crop demand for water, it reduces nematode survival between the dry spell.
- **Fertigation with bio-control agents:** through drip irrigation system, nematode suppressive bio-control agents like *paecilomyces lilacinus*, *Trichoderma harzianum* etc. and morphology-directed nanocarriers can be directly applied to the plant rhizosphere for nematode management.

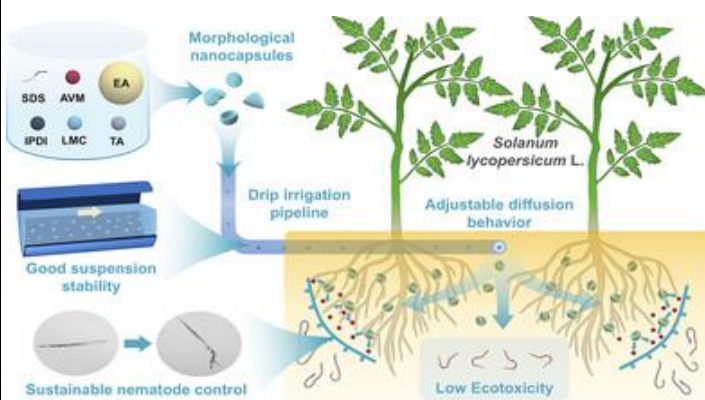


Fig 1: Morphology-directed nanocarriers applied through drip irrigation for nematode management

Benefits for farmers

Precision irrigation not only suppresses nematode population in soil but also increases the fertilizer efficiency by reducing leaching. Also promotes beneficial soil microorganisms that naturally antagonize nematodes. Improved soil health and soil structure lead to long-term sustainability by enhancing crop yield, ensuring better economic return.

Conclusion

Nematode management should not only rely on chemicals. By adopting precision irrigation, farmers can create an environment that reduces nematode damage while enhancing crop resilience. The future of nematode management lies not in eradication but in ecological balance, where smart water management becomes a front-line defence system.

References

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