
Adaptation Strategies of Nematodes to Environmental Stresses

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Abstract: Soil nematodes are richness group in soil animals and play important roles in soil organism decomposition, plant nutrient mineralization and circulation, and widely used to indicator studies in agriculture and forest ecosystems. Soil nematodes have strong ability to survive and adapt in many kinds of environment, they even be found in extreme conditions. This article introduces some of the strategies that soil — inhabiting nematodes use to cope with deteriorating environmental conditions and with particularly severe conditions.

Keywords: soil nematodes; environmental stresses; adaptation strategies

1. Introduction

Nematodes are a type of invertebrate that can exist in soil, freshwater, or seawater in parasitic or free living forms. More than 15000 species of nematodes have been reported, but they only represent a small portion of the total number of nematodes. Soil is a habitat rich in nematodes, with approximately 26% of the described genera inhabiting the soil through bacterial, fungal, predatory, omnivorous, or plant parasitic means. The soil dwelling stage of nematodes that parasitize insects or other animals and some genera in freshwater also survive in different forms in the soil. The normal activity of nematodes requires a water layer, so soil moisture content, relative humidity, and related environmental factors directly affect the survival of nematodes.

The soil environment provides varying degrees of protection against nematode dehydration. As long as the host is healthy, parasitic nematodes can obtain the optimal moisture content in plant roots or insect bodies to prevent dryness. The non parasitic stage or nematode can be protected in moist soil, but when the soil is dry, it faces the threat of dehydration, and the closer it is to the interface between soil and air, the greater the danger. Some uncommon plant parasitic nematodes, such as *Anguina*, *Ditylenchus*, and *Aphelenchoides*, face the risk of exposure to the air when they infect aerial plants. As aboveground plants (leaves, seeds, etc.) dry up or die due to parasitic nematodes within their bodies, this danger further increases. The intrinsic mechanisms of nematode response to environmental stress are mainly manifested in the following aspects.

2. Improvement of nematode life history

The life cycle of nematodes typically includes eggs, four larval stages (1-4th instar larvae), and adults. Most types of nematode larvae and adults have similar appearances, but there are also many significant differences. Some nematodes provide internal opportunities to resist environmental stress, such as the protective capsule of some nematodes that encapsulates the egg. Some nematodes complete the first layer of molting in their eggs, retaining the egg sheath to protect them from evolving towards the 2nd instar larvae.

3. Changes in gender ratio

The sex ratio of most nematodes is determined by the environment, including some species of hermaphroditic fusion and those mainly engaged in parthenogenesis. The production of male worms in root knot nematodes is a good example. In this type of nematode, the nematode hatches from the egg to a movable 2nd instar larva, which can move to the soil or plant root tissue, establishing a persistent feeding site there. Once the 2nd instar larvae start feeding, they cannot move and begin to grow in size. They molt and develop into females for parthenogenesis. Male worms are rare in root knot nematodes, but in some cases they can make up 60% of the total

nematode population. Many stressors can lead to an increase in male insect yield, including nutrient deficiency or reduced photosynthesis of the host plant, age of the host plant, plant growth regulators or inhibitors, increased population density of nematodes, emergence of plant pathogens, resistance levels of the host plant, and even temperature and radiation. If subjected to stress during the developmental stage, the 2nd instar larvae that can develop into females will undergo gender transformation, producing intersex bodies or males. Producing fertilized eggs may be a better option to survive in unfavorable environments, as an increase in the production of male root knot nematodes can lead them to leave stressed areas or plants.

Nematodes are the most abundant invertebrates in soil and play an important role in the food web of soil ecosystems. They are the foundation of material cycling and soil mineralization processes, as well as indicator organisms for soil and other ecological changes. They play an important role in soil ecosystems. Soil nematodes adapt to changes in the external environment through changes in their internal mechanisms, in order to better live in various habitats. Understanding the adaptability of nematodes to extreme environments can further develop the use of nematodes as biological indicators to indicate the status of soil ecosystems affected by external disturbances and changes in soil environment.