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Study on Life Stages of Meloidogyne Spp. In Different Crop Plants

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Abstract – The Mi gene is a single dominant gene that confers resistance to M. incognita, M. javanica, and M. arenaria. It is located near the centromere of chromosome 6. Bailey (1940) provided an early report of the wild Tomato species Solanum peruvianum as a source of resistance to root-knot nematodes. Due to reproductive incompatibilities between the Solanum lycopersicum and S. peruvianum, embryos resulting from crosses do not reach maturity. Consequently, techniques for embryo rescue techniques were developed in which immature embryos are dissected from seed and cultured axenically. The technique appears to have been first used to transfer the Mi gene from wild Tomato into commercial cultivars by Smith (1944) in crossing Solanum lycopersicum var.

Key words: M. incognita, M. javanica, and M. arenaria, Solanum peruvianum, Solanum lycopersicum.

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INTRODUCTION

Meloidogyne occurs in 23 of 43 crops listed as having plant-parasitic nematodes of major importance, ranging from field crops, through pasture and grasses, to horticultural, ornamental and vegetable crops. If root-knot nematodes become established in deep-rooted, perennial crops, control is difficult and options are limited. *Meloidogyne* spp. were first reported in cassava by Neal in 1889. Damage on cassava is variable depending on cultivar planted, and ranges from negligible to seriously damaging Early-season infection leads to worse damage.[6] In most crops, nematode damage reduces plant health and growth; in cassava, though, nematode damage sometimes leads to increased aerial growth as the plants try to compensate. This possibly enables the plant to maintain a reasonable level of production. Therefore, aerial correlations to nematode density can be positive, negative or not at all. Vegetable crops grown in warm climates can experience severe losses from root-knot nematodes, and are often routinely treated with a chemical nematicide. Root-knot nematode damage results in poor growth, a decline in quality and yield of the crop and reduced resistance to other stresses (e.g. drought, other diseases). A high level of damage can lead to total crop loss. Nematode-damaged roots do not use water and fertilisers as effectively, leading to additional losses for the grower. In cassava, it has been suggested that levels of *Meloidogyne* spp. that are sufficient to cause injury rarely occur naturally.[7] However, with changing farming systems, in a disease complex or weakened by other factors, nematode damage is likely to be associated with other problems *Meloidogyne spp*. or root knot nematodes are worldwide in distribution and they cause considerable economic loss to crops.

REVIEW OF LITERATURE:

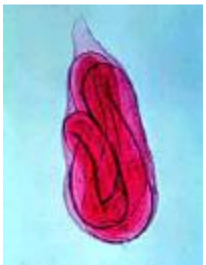
Dr. Charles Rick and colleagues at UC Davis discovered that an isozyme, acid phosphatase, is coded by the gene Aps-1 which is located on chromosome 6 of Tomato close to, and tightly linked with, Mi (Rick and Fobes, 1974). The isozyme provides a tool for Tomato breeders to determine whether they have successfully transferred Mi into commercial varieties and has facilitated the development of processing varieties with root-knot nematode resistance. The Mi gene has been cloned and sequenced in the laboratory of Dr. Valerie Williamson at UC Davis. Using *Agrobacterium* as a carrier, the resistance gene has been transferred to a susceptible Tomato cultivar, which expresses the resistance. Plants grown from seeds of the transgenic plant are also resistant to *M. incognita*. However, after the second generation of plant offspring, the expression of resistance is progressively reduced in seed batches from some plants but not from others. In both cases the gene is still present and is still coding for RNA (Goggin et al, 2004). The resistance conferred by the Mi gene breaks down at soil temperatures >28C. With repeated use of the single source of resistance in California Tomato production, aggressive strains of the nematode are being selected (Kaloshian et al. 1996).

In the early 1990s, farm advisors and entomologist Dr. Harry Lange noticed that Tomatoes with the Mi gene appeared to be also resistant to the Tomato aphid, *Macrosiphum euphorbiae*. Initial determination was that a gene tightly linked to Mi and designated Meu1 was responsible for the Tomato aphid resistance. Current research indicates, however, that the two genes are identical and that Mi confers resistance to both root-knot nematodes and the Tomato aphid. A more recent development is the discovery that the Mi gene also confers resistance against the white fly *Bemisia tabaci* (Nombela et al., 2003). The gene is located near the centromere of Tomato chromosome #6. As with the resistance to *M. incognita*, the resistance to the Tomato aphid is also progressively reduced after the second generation of plant progeny (Goggin et al, 2004).

MATERIAL AND METHOD:

Life stages of *Meloidogyne* spp. Infective J2 on left, young female on right. Most of the growth occurs during the second stage.

Mature *Meloidogyne* female (on head of pin for size perspective).



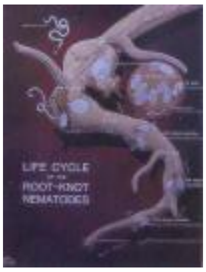
Meloidogyne male still coiled within the J4 cuticle.

Third and 4th stage within 2nd stage cuticle, passed fairly rapidly, no stylet, do not feed. Usually 4-500 eggs per egg-mass, Tyler reported a high count of 2,800.

Mass invasion of second-stage juveniles in a grape root. Only a few will establish a feeding site at this location.

Mature female at feeding site with egg mass on root surface.

Enlarged metacorpus of adult female.



Life cycle diagram

Life cycle diagram

Orion discovery of cellulases in egg-mass matrix - suggests that a hole is enzymatically digested to the root surface by the developing egg-mass.

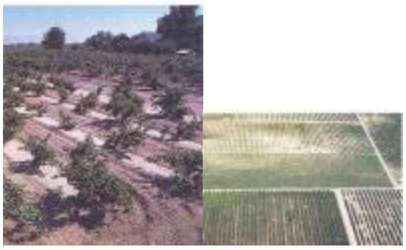
Sexual differentiation starts in late 2nd stage, heart shaped gonad. Sex reversal can occur under adverse conditions resulting in males with two testes (Triantaphyllou et al.).

Nematode exhibits a high reproductive rate.

Melakerberhan and Ferris - increase in body weight 250 fold, from 0.11µg for J2 to 300µg for total weight of female and egg mass. Total energy demand = 1 calorie, but consider repair costs, increased root metabolism, leakage, control of partitioning - effects which outweigh that of feeding.

Characteristic	Heteroderinae	Meloidogyninae
Feeding site	Multinucleate syncytium	Multinucleate giant cell
Host range	Narrow	Wide
Reproductive strategies	Sexual	Mainly parthenogenic
Eggs	Mainly retained in female body	Deposited in egg mass
Female body	Becomes hardened cyst	Does not form cyst
Hatching factors	From host root exudates	Favorable environmental conds.
Cell cycle	Endoreduplication	Acytokinetic mitosis and endure duplication

Damage:



Meloidogyne spp. damage in grape vineyards

Management:

Host Plant Resistance

Number of vegetable cultivars with resistance to common species (Fassuliotis, 1976).

	M. arenaria	*M. hapla*	*M. incognita*	*M. javanica*
Beans	0	0	12	0
Pepper	7	0	3	6
Soybeans	0	0	4	0
Cowpeas	4	1	30	4
SweetTomato	7	1	17	3
Tomato	2	1	43	7
Totals	**20**	**3**	**109**	**20**

These numbers are now higher, but the proportions are similar. The root-knot nematode *Meloidogyne javanica* causes serious damage in vegetable crops in Israel, especially in organic vegetable production systems. Incorporation of organic amendments into the soil or soil solarization does not always produce sufficient nematode control. While the use of resistant cultivars or rootstocks is an effective nematode management tool, they are not available in all vegetable crops. Further, nematode resistance, such as that in Tomato, is often undermined by high soil temperatures such as those that prevail in Israel. Consequently, nematode management strategies that can be used in organic farming systems are in demand and one such practice may be use of natural “nematicides.” Such products also may be used in conventional farming systems due to concerns for environmental and food safety.

Chemicals produced by plants are a potential source of new chemistry for development of new pesticidal compounds. Nematicidal phytochemicals are generally safe for the environment and humans

CONCLUSION:

Obviously, our teachers said, the future lay with chemicals, not with host resistance. There was nothing special about this teaching. It was typical of its time, and what is often called "state of the art". It also represented the "cutting edge of research", and the "received wisdom". It is perhaps worth adding that modern scientists often debate which of two chemicals has saved more human lives. Is it DDT, through the control of malaria, yellow fever, typhoid, and cholera, or is it penicillin?

It should also be mentioned that, in spite of the received wisdom, there are a few examples (a mere half dozen) of vertical resistance which has proved durable over many decades. Thus, wheat in Canada has durable vertical resistance to a disease called stem rust *(Puccinia graminis tritici)*, and Tomatoes in the United States have durable vertical resistance to a wilt disease *(Fusarium oxysporum* f.sp. *lycopersici)*. The reasons for this durability are too complex to discuss here, but the durability itself merits two comments. First, if we can demonstrate that a vertical resistance is durable then, obviously, we should use it. However, we should note also that vertical resistance that is durable in one part of the world is usually temporary resistance in another.

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