

HISTOPATHOLOGICAL CHANGES CAUSED BY *MELOIDOGYNE INCOGNITA* ON TOMATO AND EGG PLANT ROOTS

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ABSTRACT

Infection and development of root-knot nematodes (*Meloidogyne* species) cause histological changes in host plant tissues in the form of giant cell or syncytia and galls. The histopathology of root infections of 'Roma VF' tomato and 'Lunga violetta di Romangna' egg plant seedlings by a population of *M. incognita* race 1 was investigated at weekly intervals for 5 weeks in the glasshouse at $25 \pm 2^\circ\text{C}$. Similar histopathological changes were observed in both host plant roots due to nematode infection. The giant cell formation was well marked in the vascular region of both host roots and not in the cortex. Group formations of 4–6 or clusters of thick-walled, multinucleated, dense cytoplasmic giant cells disorganized the vascular tissue of both host plant roots.

KEY WORDS: Egg plant, Histopathology, *Meloidogyne incognita*,
Nematode, Tomato

INTRODUCTION

Root knot nematodes, *Meloidogyne* species are major pests of various crops grown in Sri Lanka (Lamberti and Ekanayake, 1980). Infection and development of root knot nematode juveniles inside host tissues result in histopathological changes in the form of giant cells or syncytia and galls. *Meloidogyne* spp. make intimate relationships with their hosts with the formation of giant cells (feeding sites) in order to obtain nutrients. The giant cells, which are usually formed around the developing nematode in the vascular region of the plant are large, multinucleate and have dense cytoplasm and highly invaginated cell walls (Bird, 1961).

Galls are the most characteristic and evident symptom of the plant to the nematode infestation. A gall develops rapidly usually within a few hours of infection, and is strictly localized around the head of the nematode

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(Godfrey and Oliveira, 1932; Dropkin, 1972). Juveniles may induce galls by feeding at the root surface without entering it with the help of their stylets (Lowenberg *et al.*, 1960). The extent of these cellular changes appears to be associated with the compatibility of the host plant to the *Meloidogyne* spp. This damage appears to be serious and can upset the normal physiological activities of vascular tissue of the root system and finally cause wilting, stunting, leaf chlorosis and poor growth of plants. Among root-knot nematodes *M. incognita* is the most aggressive and widely distributed species on vegetables (Lamberti *et al.*, 1987). Therefore the aim of this study was to investigate histopathological changes induced by *M. incognita* on tomato (*Lycopersicon esculentum* L.) and egg plant (*Solanum melongena* L.) roots.

MATERIALS AND METHODS

A population of *M. incognita* race 1, reared on tomato cultivar 'Rutgers' in the glasshouse was used in this study. Tomato and egg plant seedlings were transplanted in plastic pots containing 170 ml of steam-sterilized soil mixture (sand 80%, clay 7%, silt 4% and organic matter 3%) and allowed to grow in a glasshouse (temperature $25 \pm 2^\circ\text{C}$) at Istituto Di Nematologia Agraria, C. N. R., Bari, Italy. Four days after transplanting, plants were inoculated by placing one mature egg mass of the nematode (containing 600—800 eggs and juveniles) near the root system. Four plants from each host were uprooted at weekly intervals after inoculation. Roots were washed free of soil, cut into 4—5 mm lengths, fixed in FAA (Formalin—acetic acid—ethanol mixture), dehydrated in tertiary-butyl alcohol and embedded in paraffin. Fixed tissues were then sectioned at 10—15 μm , stained using saffranin and fast green on gelatin-coated glass slides and mounted in Dumar Xylene (Johansen, 1940). Temporary mounts were prepared for micro-photographs.

RESULTS AND DISCUSSION

Root sections of both tomato and egg plants were observed 1 week after inoculation (WAI). Infective second stage juveniles were observed only in the cortex of tomato roots and some of the roots showed that juveniles had entered only partially into the root tissue (Fig. 1A). Several juveniles had penetrated the root tips and orientated in various directions vertical or parallel to the longitudinal axis of the root. It is clear that the juveniles penetrate the root just above the root cap and several juvenile penetrations

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at the same time resulted in distortion and cell necrosis in the undifferentiated cells of the apical region of the primary root (Fig. 1B). Christie (1936) also found that the root cap cells of tomato were missing after 24 hours from inoculation due to penetration of several *Meloidogyne* at the same time.

Two weeks after inoculation, small root galls were observed on both hosts. In egg plant roots the first juvenile penetration and galling had occurred at 1 WAI. Transverse sections of root galls showed abnormally enlarged cells in the vascular region in the proximity of each nematode (Fig. 2A 3B and 3C). There was evidence that the juveniles had migrated towards the vascular region and established themselves in this area in order to feed. From this time on, until maturity the nematode remains in the same position. Females continue to live as sedentary parasites, while mature males leave the root. Jones and Northcote (1972) observed retardation of normal differentiation in cells near the head of the developing nematode. These abnormal cells are the beginning of giant cells. In this study, a transverse section of tomato root at 3 WAI (Fig. 2B) showed the nematode head inserted in the intercellular space between giant cells. In both host roots, giant cell formation was well marked in the vascular region with the development of nematodes. Similar histopathological changes were observed in both host plant root tissues. Groups of 4 to 6 giant cells were observed around the developing nematode. The size as well as number of giant cells varied. In some sections more than one group of giant cells were observed in both host plants at 3 and 5 WAI (Fig. 2B, 2C and 3E). This is due to the presence of several nematodes at the same locus. In a normal secondary root of egg plant, the undamaged phloem and protoxylem were found in the vascular region (Fig. 3A). In infected roots, clusters of giant cells and various juvenile stages of the nematode were found in the vascular region (Fig. 2C and 3E). The formation of giant cells in the proximity of each nematode causes aberration of the vascular region. Consequently, the vascular region of smaller lateral roots were badly damaged due to the giant cell formation at 5 WAI (Fig. 2C).

In this study, giant cell formation was well marked in the vascular region of both hosts rather than in the cortex. Giant cells observed at 4 to 5 WAI in both hosts were thick-walled and had dense cytoplasm. Vacuolated giant cells also were observed in the same region (Fig. 2B, 2C, 3D and 3E).

Taylor (1976) observed giant cells mostly in the region of the phloem and few in the xylem and cortical tissues and noted thin walls in the giant cells. Observations of this study were in agreement with those of Siddiqui and Taylor (1970), who observed thick walled giant cells only in the vascular region of wheat and oat roots infected by *M. naasi*. Tandon and Praveen Kumar (1979) observed clusters of giant cells, only in the vascular region and not in the cortical tissue of tomato roots parasitized by *M. lucknowica* Singh.

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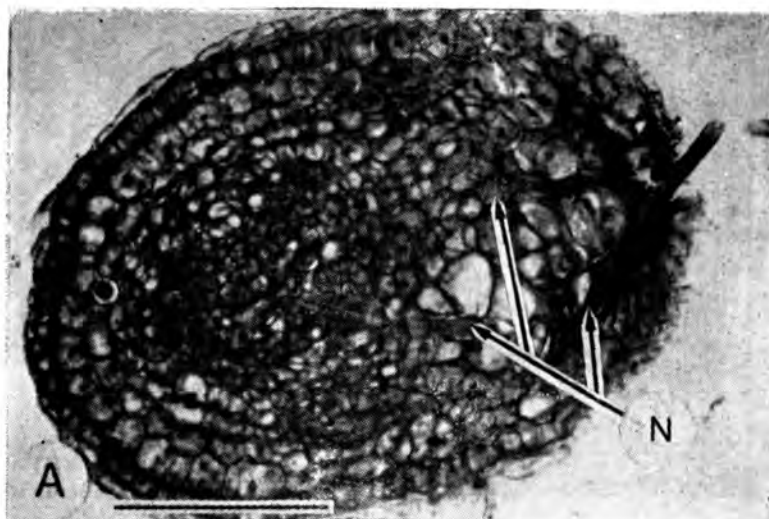


Fig. 1 (A). Transverse section of tomato (Roma VF) primary roots showing partial penetration of second stage juvenile (N) of *M. incognita* race 1 via cortex and several juveniles migrating (N) toward the vascular region. Scale bar = 100 micrometres.

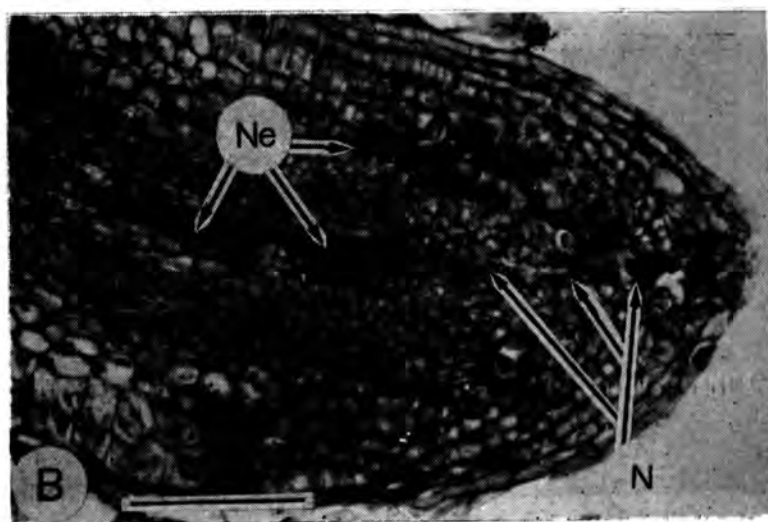


Fig. 1 (B). Longitudinal section of an apical region of tomato (Roma VF) showing cell necrosis (Ne) due to penetration by several juveniles (N). Scale bar = 100, micrometres

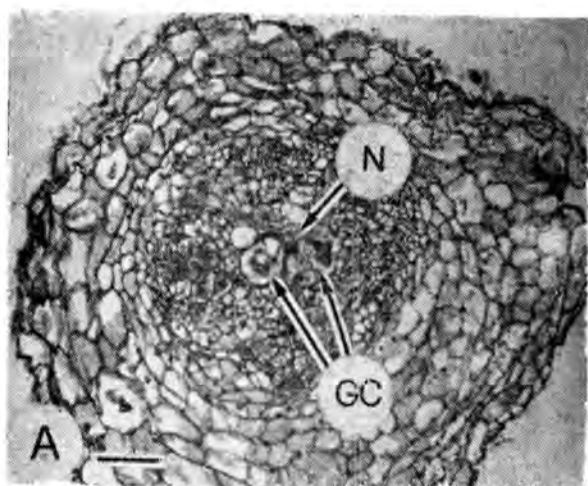


Fig. 2 (A). Transverse section of tomato (Roma VF) secondary root showing developing nematode (N) and giant cells (GC) of *M. incognita* race 1 at 2 WAI. Scale bar = 100, micrometres.

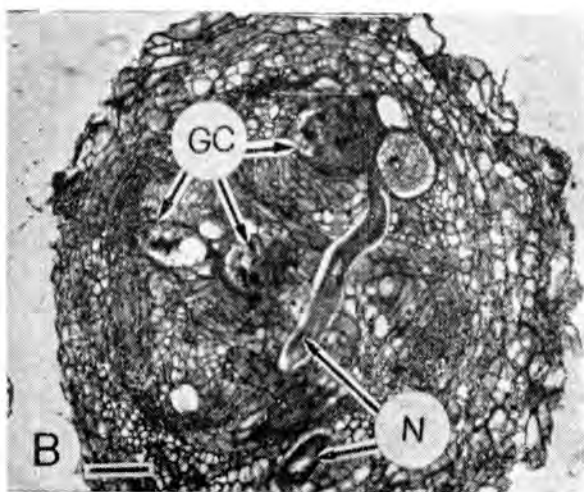


Fig. 2 (B). Transverse section of tomato (Roma VF) secondary root showing many groups of giant cells (GC) resulting from several nematodes (N) at 3 WAI. Scale bar = 100, micrometres.

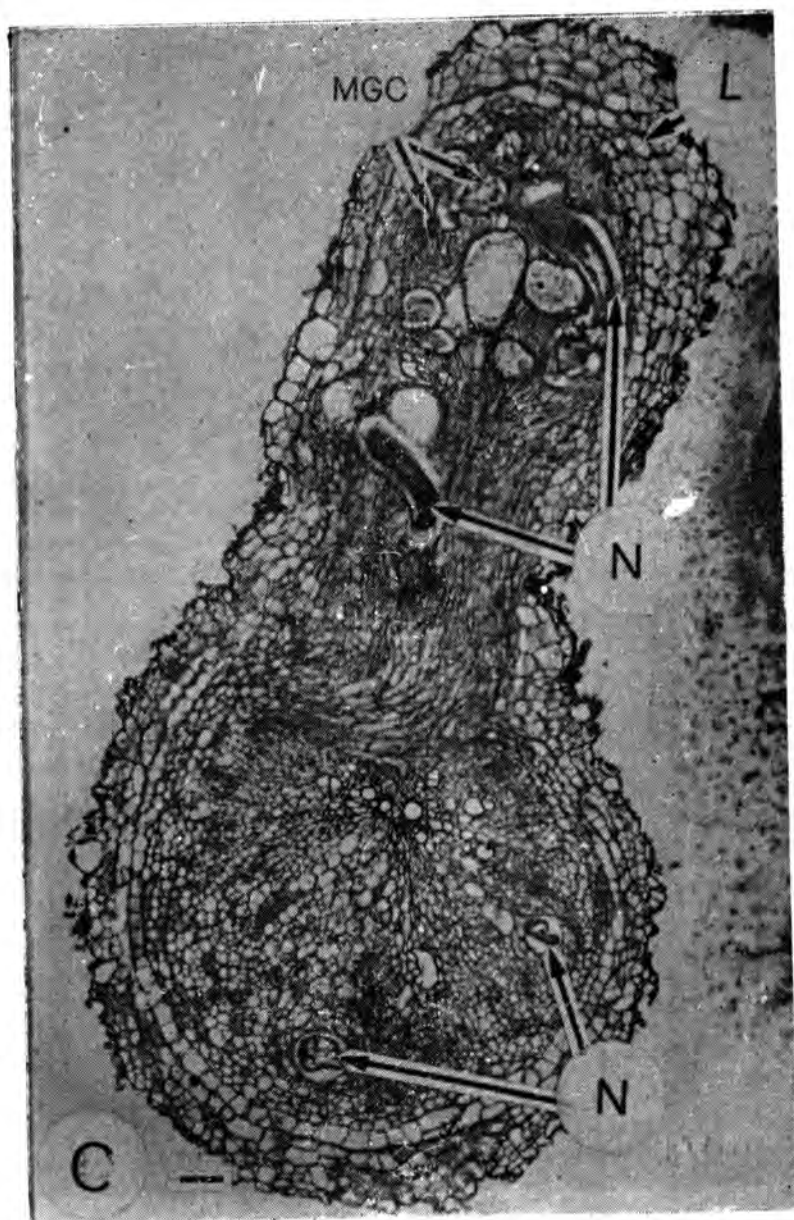


Fig. 2 (C). Transverse section of an infested lateral root and a main root of tomato (Roma VF) with many multinucleate giant cells (MGC), and several nematodes (N) in vascular region of both roots. Scale bar = 100 micrometres.

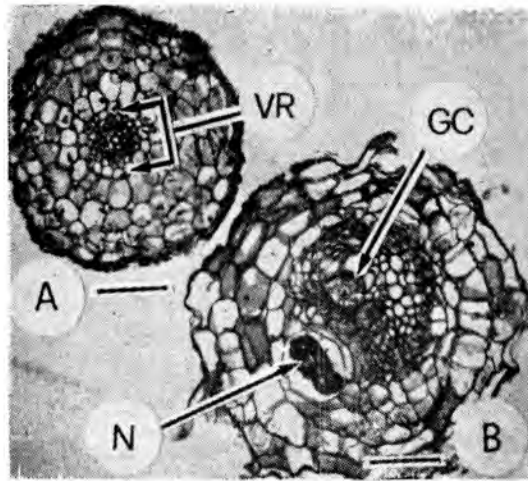


Fig. 3. Transverse section of egg plant (*Linga violetta di Romagna*) (A) uninfected primary root showing undamaged vascular region (VR), and (B) infected primary root showing nematode (N) and a group of giant cells (GC) at 2 WAI. Scale bar=100, micrometres

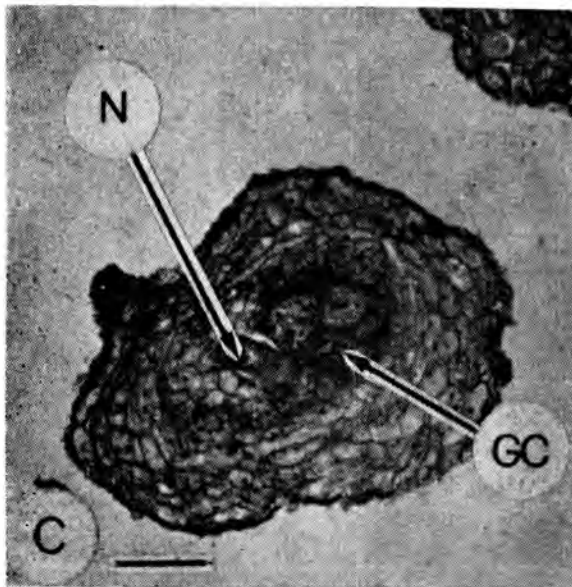


Fig. 3(C). Transverse section of infected egg plant (*Lunga violetta di Romagna*) root showing 6 giant cells (GC) proximal to the nematode (N) at 3 WAI. Scale bar=100, micrometres.

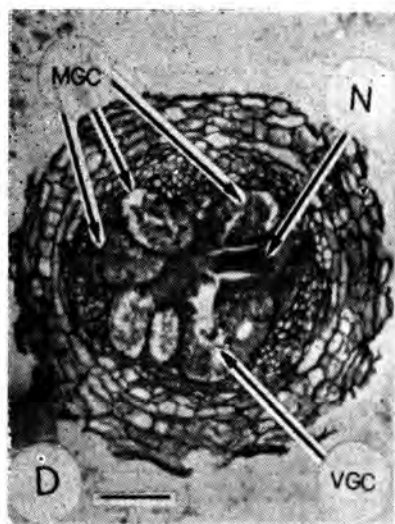


Fig. 3 (D). Transverse section of infected egg plant (*Lunga violetta di Romagna*) root showing thick-walled, multinucleate, dense cytoplasmic giant cells (MGC), vacuolated giant cells (VGC) and the nematode (N) at 4 WAI. Scale bar = 100, micrometres.

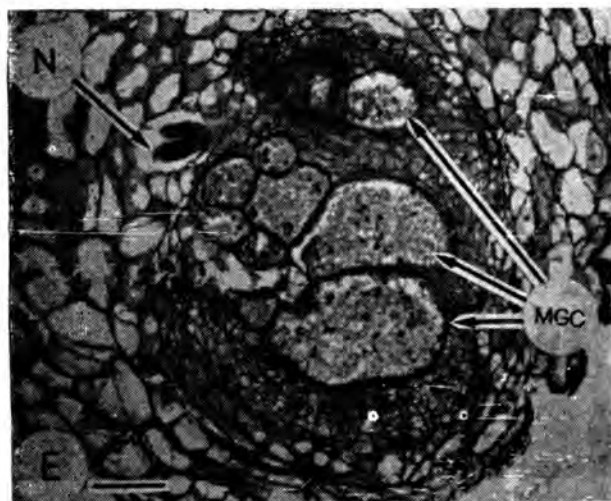


Fig. 3 (E). Transverse section of infected egg plant (*Lunga violetta di Romagna*) root showing clusters of multinucleate giant cells (MGC) at 5 WAI. Scale bar = 100, micrometres.