OBSERVATIONS ON THE BIOLOGY OF *MELOIDOGYNE INCOGNITA* AND THE DIAGEOTROPICA TOMATO MUTANT

Lisa Richardson and Nigel S. Price *

The diageotropica *(dgt)* mutant of tomato *(Lycopersicon esculentum* Mill.) is a single gene mutant first described by Zobel (1972). Its characteristics are unsupported horizontal shoot growth (hence its name), dark green hyponastic leaf segments, thin rigid stems with abnormally thick phloem fibres and an absence of large secondary xylem vessels, and a root system essentially devoid of lateral roots. Since root tips are the preferred entry points for the plant endoparasitic nematode *Meloidogyne incognita* (Kofoid & White) Chitwood an experiment was conducted to assess the effect on the nematode of such unusual root morphology.

Experimental and results

Thirty plants of "Ailsa Craig" and of its *dgt* mutant were grown in a sand loam mixture in pots (diameter 8.5 cm) placed in a glasshouse at approximately 25°. The initial shoot length of all plants was approximately 14 cm ; normal Ailsa Craig being five weeks from sowing whereas the slower growing *dgt* plants were eight weeks old.

Second-stage juveniles of *M. incognita* were hatched from egg masses of a glasshouse culture maintained on tomato, and 2 000 juveniles were added to the soil at the stem base of fifteen plants of each genotype.

Each week for five weeks after inoculation three inoculated and three uninoculated control plants of each genotype were harvested and fresh weight of shoot and roots determined. The number of galls on roots was estimated visually on the following scale : 0 = 0 galls, 1 = 1-30, 2 = 30-100, 3 = 100-200, 4 = 200-300, 5 = > 300 galls. Roots were fixed and stained in hot lactophenol cotton-blue and cleared in lactophenol (Southey, 1970). Roots were macerated in a blender and examined for nematodes under a stereoscopic microscope. Nematodes were categorized as either vermiform J2 nematodes, swollen juvenile stages or adult females. "Main" and "lateral" root tips present (distinguished by size) were also counted.

Dgt. plants showed typical growth symptoms of thin rigid stems, dark green leaves and an absence of lateral roots. Estimates of lateral root tip numbers at week 1 were approximately 164 for Ailsa Craig and 43 for *dgt.* However, the characteristic horizontal growth of shoots was not apparent.

No statistical analysis is given with these results. Root fresh weights were similar for both plants with both treatments and *dgt* shoot fresh weights showed no differences between the inoculated and control plants (Fig. 1). Shoot weight of "Ailsa Craig" was reduced, though not significantly, by *M. incognita* compared with the control plants at week 2, 3 and 4. (Lack of statistical significance may be due to the low number of replications.)

One week after inoculation 30% of the juveniles added had invaded "Ailsa Craig" whereas less than 6% had invaded *dgt* (Fig. 2). In Ailsa Craig swollen juveniles were present after two weeks and adult females present after three weeks. Most nematodes in *dgt* did not develop beyond the J2 stage. Some swollen juveniles developed but the presence of adult females was only noted at five weeks.

Galling occurred on inoculated Ailsa Craig by week 2, indices being recorded as 3, 4, 5 and 5 for weeks 2, 3, 4 and 5 respectively. A few galls developed on inoculated *dgt.* by weeks 4 and 5 roots receiving ratings of 1 and 1. Galls on *dgt* were generally half the size or less of those on "Ailsa Craig".

Discussion

Since the objective of this project was to assess the effect of differing root morphologies on invasion by *M. incognita* the more slowly growing *dgt* were three weeks older than Ailsa Craig, but with a similar root fresh weight. The lower invasion of *dgt* roots may be due to the lower numbers of laterals on *dgt* providing fewer entry sites for juveniles. Prot (1976) however has demonstrated that different cultivars of tomato may differ in their attractiveness to juveniles of *M. javanica*, and *M. incognita* may leave roots of resistant alfalfa after invasion (Reynolds, Carter & O'Bannon 1970).

The characteristics of the *dgt* mutant are considered to derive from altered ethylene physiology. Zobel (1973) considered this to be due to an inability of the plant to synthesize ethylene and showed that exogenous ethylene restored normal leaf, shoot and root characteristics to the growing regions. Jackson (1979) however found *dgt* to produce ethylene and

Dept of Zoology, University of Reading, Whiteknights, Reading Berks. RG6 2AT, U.K.

* *Present address: Dept of Plant Pathology, University of Georgia, Athens, Ga 30602, USA.*

concluded that it was the plants response mechanisms to gravity and ethylene that had been altered by the mutation. He suggested that it was this reduced response that was overcome by exogenously applied ethylene.

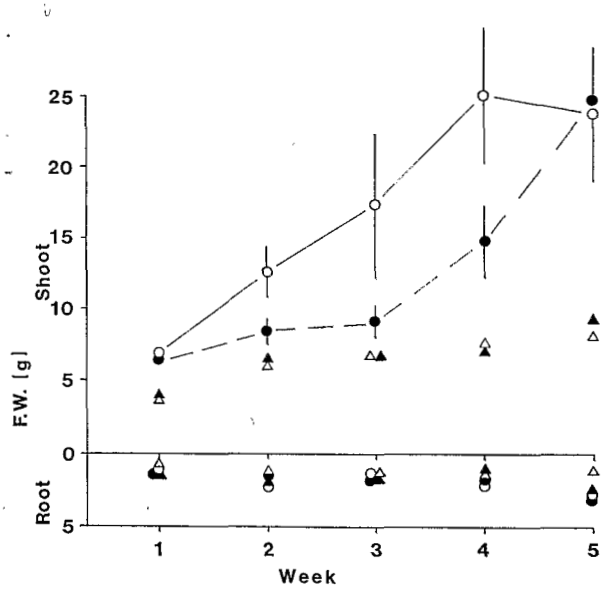

Fig. 1. Fresh weights of Ailsa Craig and diageotropica tomato plants with and without *M. incognita* (Mean values, n = 3, standard errors attached to Ailsa Craig shoot weights only) white circles : Ailsa Craig controls, black circles : Ailsa Craig + nematodes, white triangles, *Dgt* controls, black triangles, *dgt* + nematodes.

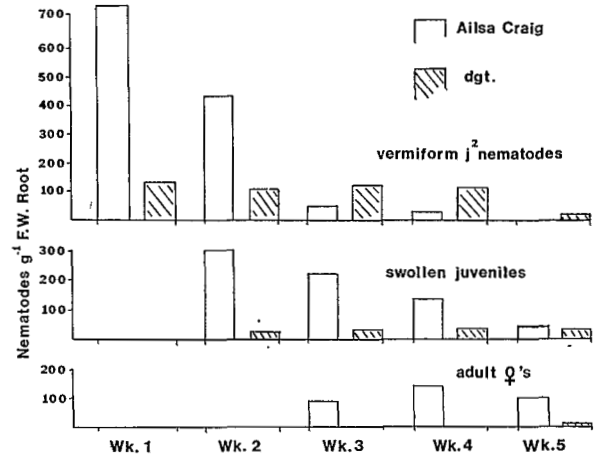

Fig. 2. The development of *M. incognita* on Ailsa Craig and *dgt* tomatoes.

The suppressed and delayed galling, and arrested nematode development suggest that *dgt*'s altered physiology affects its response to *M. incognita*. Galling is a plant response to nematode invasion, probably to secretions from the nematode and can occur without nematode penetration (Bird, 1974). The low numbers of galls on *dgt* could be due to fewer nematodes invading, but the delayed appearance and smaller size suggest a lower response to the galling stimulus. The failure of most J2 nematodes to mature in *dgt* plants suggests that the plant also failed to respond to the nematode stimulants in a manner that normally leads to the establishment of a feeding site (Bird, 1974). This needs to be confirmed by histological examination.

Plant hormones (including ethylene) and possibly nematode produced hormones are involved in the host-parasite relationship (Veech, 1981). Dropkin, Helgenson and Upper (1969) broke resistance in tomato to *M. incognita* with exogenous cytokinins and Sawhney and Webster (1975) increased susceptibility of tomato to *M. incognita* with exogenous auxin and cytokinin. Here we are able to show that a host species genotype known for its hormonal abnormalities will not support the development of *M. incognita*, suggesting the importance of ethylene and ethylene mediated responses in the host-parasite relationship. It would be interesting to see if normalizing the growth of *dgt* with exogenous ethylene conferred normal host status to *M. incognita* on *dgt* plants.

Dgt can be considered "tolerant", growth in the presence of the parasite apparently unaffected, and "resistant", the parasite failing to develop in the host. The unusual basis for these characteristics could provide a useful research tool in investigations of nematode-plant physiology and biochemistry.

References

Bird, A.F. (1974). Plant response to root knot nematode. *A. Rev. Phytopath.*, 12 : 69-85.

Dropkin, V. H., Helgenson, J. F. & Upper, C.D. (1969). The hypersensitivity reaction of tomatoes resistant to *Meloidogyne incognita* : Reversal by cytokinins. *J. Nematol.*, 1 : 55-61.

Jackson, M.B. (1979). Is the diageotropica tomato ethylene deficient ? *Physiol. Plant.*, 46 : 347-351.

Prot, J.C. (1976). Amplitude et cinétique des migrations du nématode *Meloidogyne javanica* sous l'influence d'un plant de tomate. *Cah. ORSTOM, Sér. Biol.*, 9 : 157-166.

Reynolds, H.W., Carter, W.W. & O'Bannon, J.H. (1970). Symptomless resistance of alfalfa to *Meloidogyne incognita acrita*. *J. Nematol.*, 2 : 131-184.

SAWHNEY, R. & WEBSTER, J.M. (1975). The role of plant hormones in determining the resistance of tomato plants to the root-knot nematode *M. incognita*. *Nematologica*, 21 : 95-103.

SOUTHEY. J.F. (1970). Laboratory methods for work with plant and soil nematodes. *Minist. Agric., Fish. Fd, Tech. Bull.* No. 2, London, 148 p.

VEECH, J.A. (1981). Plant Resistance to Nematodes. In : Zuckerman, B.M. & Rhode, R.A. (Eds). *Plant Parasitic Nematodes, Vol. III*. New York, Academic Press, 508 p.

ZOBEL, R.W. (1972). Genetics of the diageotropica mutant of tomato. *J. Hered.*, 63 : 94-97.

ZOBEL, R.W. (1973). Some physiological characteristics of the ethylene requiring tomato mutant diageotropica. *Pl. Physiol.*, 52 : 385-389.

Accepté pour publication le 28 juillet 1983.

Dates de publication du volume 6

Fascicule 1 (p. 1-154) ..... 22 juillet 1983

Fascicule 2 (p. 155-338) ..... 23 janvier 1984