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CELLULAR RESPONSES OF THREE SUSCEPTIBLE CULTIVARS OF POTATO TO INVASION BY THE JUVENILES OF *GLOBODERA PALLIDA*

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A general distinction between the cellular responses of the roots of resistant and susceptible cultivars of potato to invasion by potato cyst nematodes is reported as hypersensitivity. This condition is expressed by localised lignification and necrosis around the nematode and the developing syncytium, in resistant cultivars. Eventually the lignification walls off the syncytium, thereby preventing its continued expansion (Hoopes, Anderson & Mai, 1978; Rice, 1983, Rice, Leadbeater & Stone, 1985).

Susceptible cultivars allow the incorporation of cells into the syncytium and their further proliferation to proceed unchecked; simple mechanical damage without lignification is the only evidence of the passage of the nematode through the root tissues.

Evans, Greet and Inge (1983) reported that potato cultivars with no resistance to *Globodera pallida* Stone exhibited different degrees of tolerance to this nematode. The same authors described experiments which related these differences in tolerance to the interaction between the nematode and the wilt fungus *Verticillium dahliae* (Kleb.). Three cultivars of potato, Maris Anchor, Maris Peer and Pentland Javelin, gave very different responses to invasion by *G. pallida.*

Sixty tuber pieces bearing single sprouts of the three potato cultivars were incubated on 2 % water agar (containing 0.005 % streptomycin sulphate) at 20° in the dark. After ten days, 10 µ of 2 % carboxymethylcellulose containing 20 newly hatched juveniles of *G. pallida* were placed on roots growing on the surface of the agar; additions were made at the root tip or at 2.5 cm, 4.5 cm, 6.5 cm or 8.5 cm from the root tip. The plants were then returned to the incubator and 1.0 cm segments around the inoculation points harvested eight days later. The segments were fixed immediately in F.A.A. and processed through a tertiary butyl alcohol series to wax (Southey, 1970); 10 µm sections were stained in either Sudan Black B or Safranin O and Fast Green.

Fig. 1 A-C shows the structure of the root of each cultivar at 2.5 cm from the tip. Pentland Javelin (Fig. 1A) has large diameter roots, a well developed cortex of up to eleven layers of thick walled cells, a thickened epidermis, no distinct hypodermis and a well developed pentarch xylem. Maris Peer (Fig. 1B) has thinner roots, a less developed pentarch xylem, up to eight layers of thinner walled cortical cells and possesses a well developed hypodermis thickened on its radial and outer tangential walls. Maris Anchor (Fig. 1C) has very thin roots, a tetrarch xylem, a cortex with up to only five layers of large thin walled cells of which the outer layer forms a distinct hypodermis.

Pentland Javelin exhibited the expected susceptible response to invasion by nematodes (Fig. 2A) with little tissue damage and hypersensitivity shown only by those cells adjacent to the nematode and with no lignification around the developing syncytium. However, Maris Peer (Fig. 2B) and Maris Anchor (Fig. 2C) both exhibited a marked hypersensitivity in several layers of cells around the nematode, which in Maris Anchor spread rapidly through the surrounding tissue often resulting in its collapse. Lignification around the syncytium also occurred but was not pronounced; evidently the

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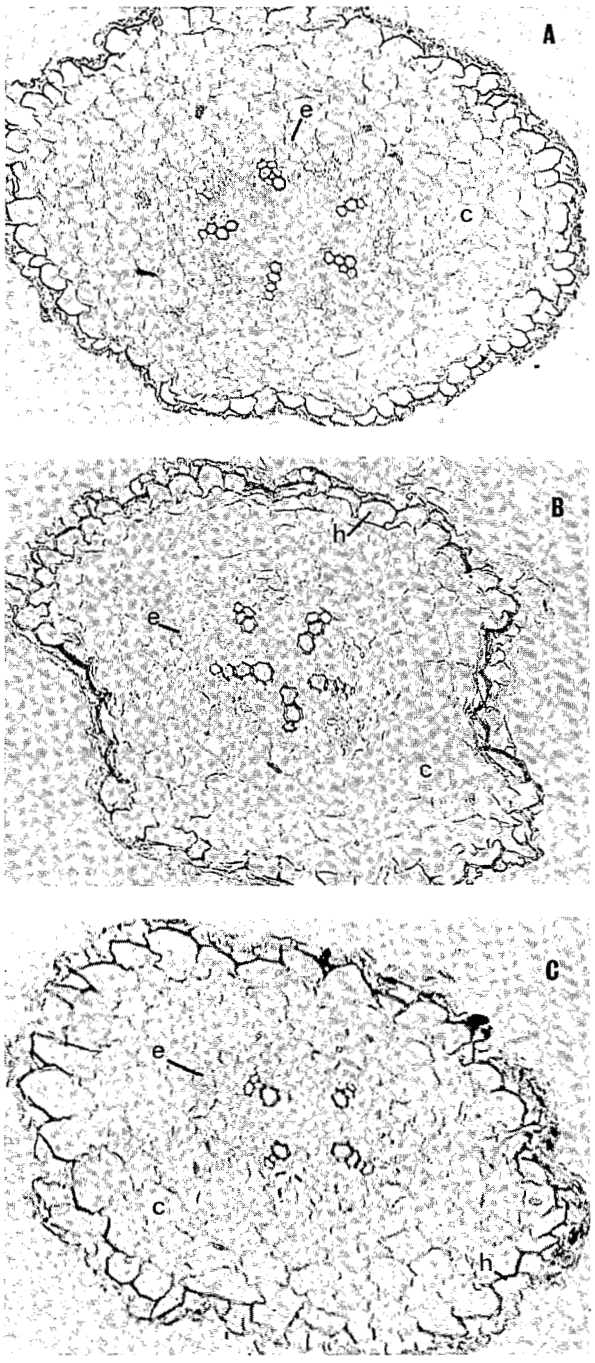

Fig. 1. Transverse sections from potato roots. Cultivars : Pentland Javelin (A) × 200; Maris Peer (B) × 250; Maris Anchor (C) × 256. Endodermis (e), Cortex (c), Hypodermis (h).

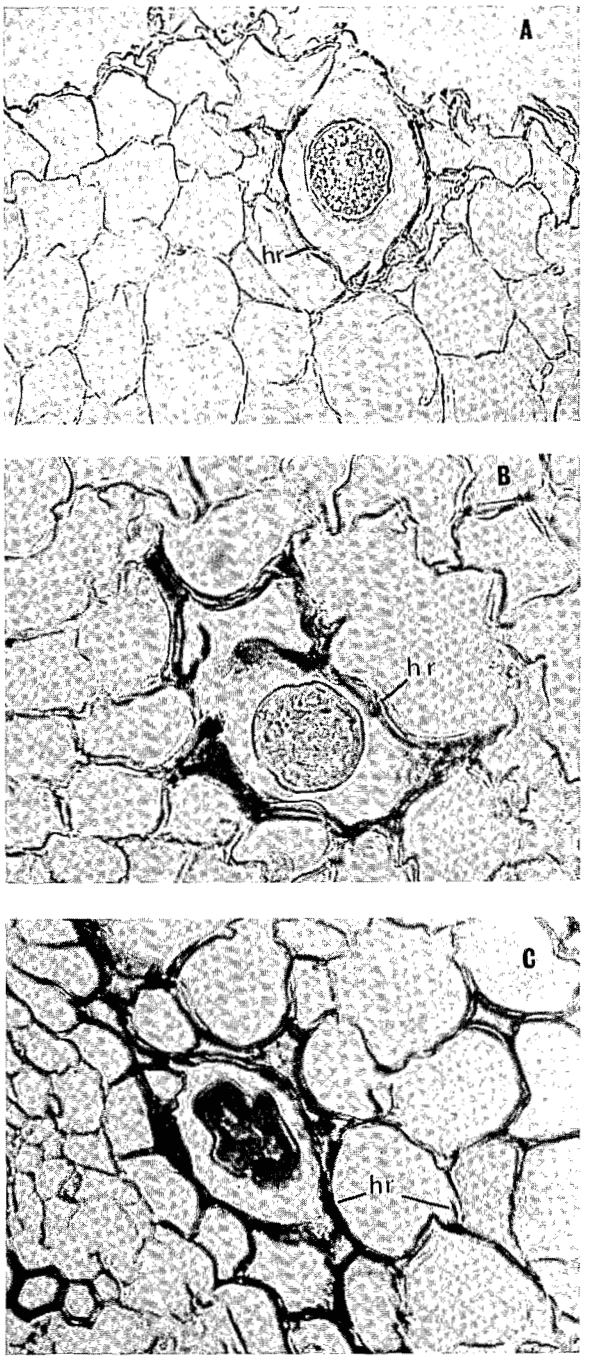

Fig. 2. Cellular responses of potato roots to invasion by *G. pallida* juveniles. Cultivars : Pentland Javelin (A) × 500; Maris Peter (B) × 750; Maris Anchor (C) × 640. Nematode (n), Hypersensitive response (hr).

development of the syncytium was not impeded as no degenerate syncytia were seen.

It is recognised that the cellular responses of partially or completely resistant cultivars can take different forms according to their complement of resistance genes (Rice & Stone, 1983). However, previous studies have concluded that all susceptible cultivars show similar cell responses (Hoopes, Anderson & Mai, 1978) viz. an insensitivity to tissue damage with necrosis confined to the cells adjacent to the nematode and with no necrosis around the syncytium, although Huijsman, Klinkenberg and Den Ouden (1969) noted greater or lesser amounts of necrosis around syncytia when they degenerated after the nematodes completed their development. In the present experiments Pentland Javelin exhibited the typical susceptible response. However, the susceptible cultivars Maris Peer and Maris Anchor both showed extensive necrosis in the tissues surrounding the nematode; both of these cultivars also have a lignified hypodermis and produce lignitubers in response to invading fungal hyphae. Pentland Javelin does not have a hypodermis and although it does produce lignitubers, it is not so prone to produce a hypersensitive response to the nematode.

A range of responses to nematode invasion is already recognised in resistant cultivars; apparently, a range of responses may also occur in susceptible cultivars.

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INCREASE OF THE CHEMICAL OXYGEN DEMAND DURING THE GROWTH IN *HETERODERA SACCHARI*

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In nematodes species which remain vermiform at any stage of development, quantitative study of the growth may be approached by measuring increases of length and width (Bird, 1971; Ohba & Ishibashi, 1981). In the case of species which become swollen at later stages, such as *Meloidogyne javanica,* Bird (1959) showed that measurement of area with the camera lucida gave a better appreciation of the increase in size. This author however suggested that " measurements of volume or weighing would give better representation of the rate of growth. The size of these creatures predisposes against these techniques, however ". In the present work, I measured the growth of females of *Heterodera sacchari* by means of the chemical oxygen demand (COD), that is the oxygen required for the complete oxidation of the organic matter in the nematode with an oxidizing chemical (Reversat, 1981*a*)

Material and methods

Heterodera sacchari was reared on two cultivars of rice (*Oryza sativa*) : Morobérékan, traditional in Ivory Coast, and IR 1529, introduced from the International Rice

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