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Tylose formation in elms after inoculation with Ceratocystis ulmi, a possible resistance mechanism

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Abstract

After inoculation of elms with *Ceratocystis ulmi* tylose formation in vessels of the susceptible clone 'Belgica' appeared to be delayed in comparison with tylose formation in the resistant clone '390'. It is suggested that tylose formation may be a resistance mechanism in elms to Dutch elm disease.

Introduction

Tylose formation in xylem vessels has been described as a possible resistance mechanism in banana and in tomato to *Fusarium* wilt (Beckman et al., 1962; Beckman and Halmos, 1962; Beckman, 1966; Beckman et al., 1972). In the incompatible host-parasite combination a rapid tylose formation seals off the vessels in advance of the pathogen, by which the infection is localized. In the compatible host-parasite combination, however, tylose formation is delayed allowing the pathogen to spread through the whole plant.

In the case of elms resistant to *Ceratocystis ulmi* (Buisman) C. Moreau, the vascular anatomy was considered to be a factor in the resistance mechanism (Elgersma, 1970; McNabb et al., 1970).

Although an attempt was made to determine whether a more rapid blockage of vessels also occurs after inoculation in resistant elms, so far a significant difference in the rate of occlusion of the lumina of the vessels between resistant and susceptible elms was not found (Elgersma, 1969). However, at that time observations were restricted to only 3 days after inoculation and the number of vessels showing blockage was rather small. Therefore similar experiments were carried out, but this time observations were taken during a longer period after inoculation, while at the same time the inoculum density was increased.

Materials and Methods

Two-year old twigs from nursery grown elms of the resistant clone '390' and the susceptible clone 'Belgica' were inoculated with the *C. ulmi* strain TX 36. Inoculum was prepared and inoculations were carried out as described by Elgersma (1969). A spore suspension of 5.10^5 spores per ml was used.

On the 2nd, 3rd, 5th, 7th and 10th day after inoculation twig pieces of 3 cm length were cut 6 cm above the site of inoculation, using 10 twigs from each clone at a time. These pieces were fixed in formaline (40 %)-ethanol (70 %) – propionic acid (5:90:5)

for about a week, then rinsed with tapwater overnight and subsequently stored in ethanol (96%) – water – glycerol (1:1:1). Cross-sections 30 μm thick were made, using a Reichert sliding microtome; sections were mounted on a slide in a solution containing 35 g mowiol N50–88, 110 ml destilled water, 50 ml glycerol and 2 g phenol (Fokkema, 1971). Each time 3 sections were examined from each twig. The total number of vessels as found in the latest developed annual ring was counted and the number with tyloses determined. To restrict the number of vessels that had to be counted and because the smaller ones were too difficult to distinguish from other xylem elements, only vessels with a diameter of minimal 30 μm were taken into account. In order to compare the data from various countings, the number of vessels which showed tyloses per 1000 vessels as seen in the cross-section was determined. The data were subjected to the Wilcoxon two sample test.

Results and discussion

At 3 and 5 days after inoculation the number of vessels which showed tyloses appeared to be significantly higher ($p < 0.002$) in the resistant clone '390' than in the susceptible clone 'Belgica' (Fig. 1). So tylose formation might be a factor in resistance, as in the case of *Fusarium* wilt of banana and tomato. This mechanism can be even more effective in localizing infection in the resistant clone '390', as in this clone vessels are shorter and smaller in diameter than in the susceptible clone 'Belgica' (Elgersma, 1970).

As was shown earlier, fungitoxic compounds formed after inoculation do not play a decisive part in localizing the fungus, as these compounds are produced in comparable quantities in susceptible and resistant clones (Elgersma and Overeem, 1971) Also in the case of *Fusarium* wilt of tomato no evidence was found that fungitoxic compounds are primarily responsible for resistance (Elgersma et al., 1972).

Deducing from data obtained from other host-pathogen combinations as *Fusarium*

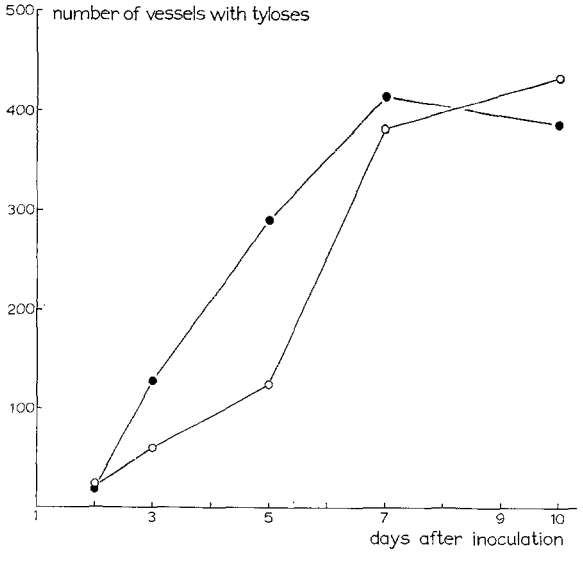

Fig. 1. Number of vessels showing tyloses per 1000 vessels in cross-section. ● – ● resistant, ○ – ○ susceptible clone.

Fig. 1. Aantal vaten met thyllen per 1000 vaten in doorsnee. ● – ● resistent, ○ – ○ vatbare kloon.

oxysporum f. *cubense* in banana and *Fusarium oxysporum* f. *lycopersici* in tomato, it seems likely that any injury, chemical or physical, induces a rapid tylose formation in the xylem vessels, by which the plant seals off the vessels preventing the spread of micro-organisms. Only when a susceptible host is attacked by a pathogen tylose formation is inhibited. May be the pathogen is producing a compound which inhibits tylose formation in the susceptible host. This hypothesis is in agreement with the knowledge that resistance is a rule and susceptibility an exception with plants.

The reason that no significant differences in tylose formation between susceptible and resistant clones were found in earlier experiments (Elgersma, 1969) is probably due to the fact that at what time too low a concentration of spores was used.

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Samenvatting

Thyllenvorming in iepen na inoculatie met Ceratocystis ulmi, een mogelijk resistentiemechanisme

Na inoculatie van iepen met *Ceratocystis ulmi* bleek de thyllenvorming te zijn vertraagd in de vaten van de vatbare kloon 'Belgica' in vergelijking met de thyllenvorming in de resistente kloon '390' (Fig. 1). Thyllenvorming zou een resistentie mechanisme kunnen zijn tegen de iepziekte.

References

Beckman, C. H., 1966. Cell irritability and localization of vascular infections in plants. Phytopathology 56: 821–824.

Beckman, C. H. & Halmos, S., 1962. Relation of vascular occluding reactions in banana roots to pathogenicity to root invading fungi. Phytopathology 52: 893–897.

Beckman, C. H. Halmos, S. & Mace, M. E., 1962. The interaction of host, pathogen, and soil temperature in relation to susceptibility to *Fusarium* wilt of bananas. Phytopathology 52: 134–140.

Beckman, C. H., Elgersma, D. M. & MacHardy, W. E., 1972. The localization of fusarial infections in the vascular tissue of single dominant-gene resistant tomatoes. Phytopathology 62: 1256–1259.

Elgersma. D. M., 1969. Resistance mechanisms of elms to *Ceratocystis ulmi*. Meded. phytopath. Lab. Willie Commelin Scholten 77: 1–84.

Elgersma, D. M., 1970. Length and diameter of xylem vessels as factors in resistance of elms to *Ceratocystis ulmi*. Neth. J. Pl. Path. 76: 179–182.

Elgersma, D. M. & Overeem, J. C., 1971. The relation of mansonones to resistance against Dutch elm disease and their accumulation, as induced by several agents. Neth. J. Pl. Path. 77: 168–175

Elgersma, D. M., Beckman, C. H. & MacHardy, W. E., 1972. Growth and distribution of *Fusarium oxysporum* f. *lycoperisici* in near-isogenic lines of tomato resistant or susceptible to wilt. Phytopathology 62: 1232–1237.

Fokkema, N. J., 1971. The effect of pollen in the phyllosphere of rye on colonization by saprophytic fungi and on infection by *Helminthosporium sativum* and other leaf pathogens. Neth. J. Pl. Path. 77, Suppl. no 1.

McNabb Jr., H. S., Heybroek, H. M. & MacDonald, W. L., 1970. Anatomical factors in resistance to Dutch elm disease. Neth. J. Pl. Path. 76: 196–205.

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