Epidemiological research on the etiology of twig scab as basis for a rational and ecological disease management

E. Croes[1], W. Van Hemelrijck[1], A. De Landtsheer[2], W. Keulemans[2], and P. Creemers[1]

Abstract

Scab is one of the key parasites in fruit growth. In favourable weather conditions for the pathogen, a complete harvest can be destroyed if no control measurements are undertaken. The scab fungi on pear and apple are two distinct species. They have, however, a similar biological cycle. Despite the similarities, there are also clear differences and these differences are significant for the control of the pathogen. Pear scab does not only infect fruit and leaves as apple scab does, but also infects twigs. Especially in organic fruit growing, twig scab is a big problem. Once twig scab occurs, it seems to be impossible to get rid of scab in these orchards. The only possibility for the fruit grower in this case is a strict spraying schedule to ensure no further spread of the infection.

The main goal of the project is a thorough study of the pear scab fungi (biology, sensitivity of different plant parts and cultivars, dispersal of the fungi and infection conditions, the pathogenicity and characterization of different biotypes) to unravel the life of the fungi and to develop a better control strategy. A better control strategy means a reduced fungicide use and a reduction of fungicide residue on the fruits at harvest, without a reduction of the quality of the fruits and cost effectiveness for the fruit grower. Special attention in the project goes to the role and the control of twig scab. The first results of this project will be shown.

Keywords: Pear, twig scab, biotype, epidemiology

Introduction

Scab on apple and pear, caused by the ascomycete *Venturia inaequalis* and *V. pirina*, respectively, is one of the most important diseases in fruit growing, due to high economic losses if no control measurements are undertaken. The fungus overwinters in the orchard on fallen, infected leaves and forms pseudothecia. During spring, ascospores are released when the climatological conditions are fulfilled. The latter were first described by the table of Mills (Mills, 1944) and adjusted later on (MacHardy and Gadoury, 1989; Stensvand *et al.*, 1997). Moreover, primary lesions produce conidia, which under favourable conditions cause a further, more local spread of the disease. In contrast to apple, pear scab does not only infect fruits and leaves, but gives rise to twig lesions as well. The presence of twig scab represents a major problem, especially in organic pear growing, as fruit growers lack satisfying measurements to put an end to the disease. Twig lesions possibly form an additional inoculum source for infections in early spring. At this moment, the relative importance of twig scab infections compared to the ascospore discharge in spring is not known. The exact correlation between fruit, leaf and twig infections too is not understood. Moreover, diverse *V. pirina* biotypes are present in different regions, orchards, on different cultivars or plant parts. Their exact nature and possible variability in pathogenicity are not identified yet. A second discrepancy between apple and pear growing is the greater importance of secondary infections for pear scab.

[1] E. Croes, Mycology, Research Station of Fruit Cultivation, Fruittuinweg 1, 3800 Sint-Truiden, Belgium, evi.croes@pcfruit.be.
[2] Laboratory of Fruit Breeding and –Biotechnology, K.U.Leuven Department of Biosystems, W. De Croylaan 42, 3001 Heverlee, Belgium, anke.delandtsheer@biw.kuleuven.be.

As the disease control for pear scab is mainly based on that of apple, it is believed that the amount of sprayings is probably too high and the timing of the treatments could be better positioned. Therefore, this study aims to enhance our insight into the epidemiology of pear scab with the emphasis on twig scab. This will ultimately lead to a decline in fungicide use, reduced amounts of residues on the fruits and alternative strategies to control pear scab.

Material and Methods

Monitoring of the epidemiology of *V. pirina*

In 2009 five Belgian pear orchards, including both conventional and organic pear growing, were selected for evaluation of twig scab on one-year-old shoots of pear trees. The number of lesions per internode was assessed weekly from May-June till August-Octobre, depending on the orchard (Table 1). The scab incidence (%) was expressed as percentage of infected internodes for each 5 internode-interval. Each internode was quoted with a value of 0 to 3 depending on the number of lesions. The infection degree (TH3) was calculated according to the formula of Townsend-Heuberger. The economically most important pear cultivar in Belgium, i.e. Conference, was present in all orchards. In one orchard the cultivar Durondeau, which is known to be highly susceptible to scab, was evaluated as well.

Table 1: Overview of scab evaluations performed in Belgian pear orchards in 2009.

Orchard	Location	Type	Cultivar	Period of evaluation
1	Kortenbos	Conventional	Conference	May-Octobre
2	Borlo	Conventional	Conference	May-August
3	Kortenbos	Conventional	Conference	May-Octobre
4	Assent	Organic	Conference	May-August
			Durondeau	May-August
5	Ezemaal	Organic	Conference	June-August

Latent presence of pear scab

Pear seedlings (4-5 weeks old) were inoculated with a spore suspension of *V. pirina* conidia (1.5 x 10^5/ml), originating from scabbed pear leaves that were dried and frozen for storage. Seedlings were incubated for 48h at 100% RH and room temperature. They were further placed in climate chambers (20°C, 90% RH, 12h light/dark cycle) for up to 2 weeks. Leaf discs were collected 12h, 24h, 48h and 3, 6, 9, 13 and 24 days after inoculation. The discs were immersed in 1:2 (v/v) ethanol: glacial acetic acid solution for 1-2 days to remove the chlorophyll. After rinsing in 5.6% HCl for 20 min, samples were placed in 0.05% (w/v) tryptan blue/lactoglycerin at 55-60°C for 10-30 min. De leaf discs were destained using lactoglycerin. Microscopic observations were performed using a Zeis Axioskop light microscope equipped with a Zeiss AxioCam digital camera and Axiovision 3.1 software (Zeiss, Göttingen, Germany).

Results and Discussion

Monitoring of the epidemiology of *V. pirina*

Despite lower amounts of rainfall in April 2009 than usually occurs in that period of the year, conditions were very favourable for scab. Severe climatological infection risks accompanied by high ascospore releases were registered on April 8th and 16th. This became visible at the beginning of May. In orchard 1 the scab incidence (%) and the TH3 were assessed for each 5 internode-interval of shoots A to Z, randomly positioned in the

tree. On average, already 56% and 12% of internodes 1-5 and 6-10, respectively, showed twig lesions (TH3=23 and 4, resp.) on May 8th. The final situation (on Octobre 6th) for shoots A to Z is visualized in Figure 1. This schematic representation shows that twig lesions are spread all over the tree. No specific regions of high or low scab incidence can be found. However, the number of twig lesions highly depends on the position on the shoot, as is also the case for leaves. On average, the % scab incidence as well as the TH3 values gradually decrease from the onset of the shoot (80-100% infestation, TH3=59) up to the end (0-20% infestation, TH3=3). This is in contrast with earlier results of Aerts et al. (1970) who stated that twig lesions on one-year-old shoots are formed during the summer and are the most abundant at the end of the shoots. They hypothesized that these twig lesions play an important role in the infection of fruits the following year.

First of all, these preliminary results need to be compared to the scab evaluations, performed in the other orchards. Next, a follow-up over the next 3 seasons is necessary to determine which factors are required for the development of twig scab and on the relationship between scab on twig, leaf and fruit.

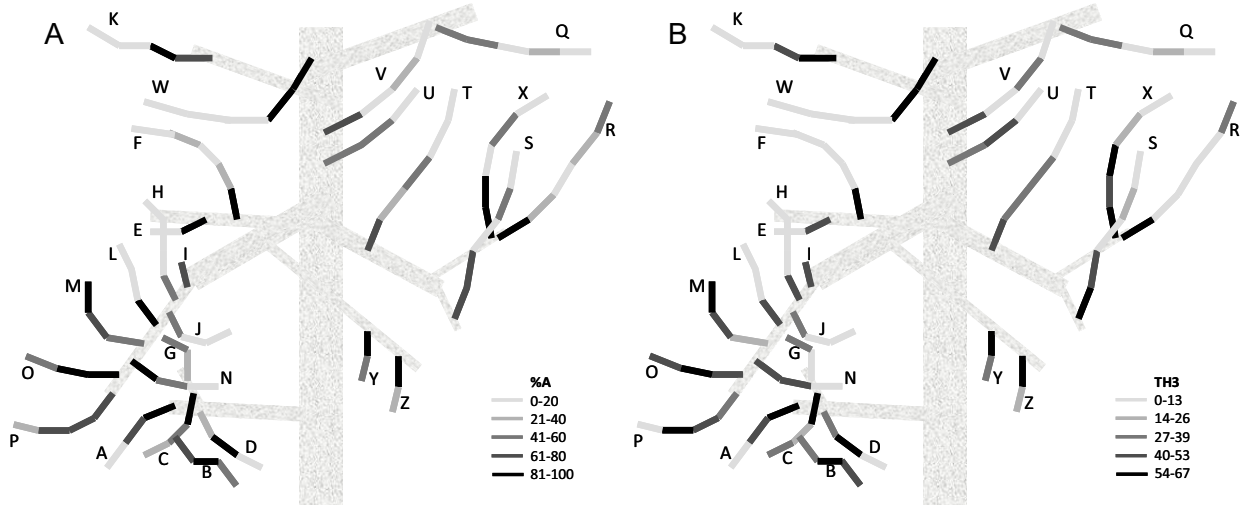

Figure 1: Schematic representation of (A) % pear twig scab infestation and (B) degree of infection (TH3) for each 5 internode-interval (branches are divided into internode-intervals 1-5, 6-10, 11-15, 16-20 and 21-25) of branches A-Z of a pear tree in orchard 1 (Kortenbos, Belgium). Different shades of grey represent (A) different % of twig infestation or (B) different degrees of infection as illustrated in the legends.

Latent presence of pear scab

V. pirina conidia can be present on leaf, shoot or fruit without visual symptoms. This latent presence of scab can occur for older, non-susceptible leaves as was shown for apple by Li and Xu (2002). Additionally, leaves, fruits and/or shoots can become infected late in summer. In the case of fruits, pin-point scab will develop during storage. In addition, symptomless leaves and shoots, containing conidia, could present a problem when they overwinter on the orchard floor. However, to date, it is not known to which extent this unknown inoculum source can contribute to infections in early spring. This information could be valuable with regard to sanitary measurements, such as the enhancement of leaf litter breakdown or the removal of wood after pruning in the fruit orchard.

Our first microscopic analyses show that conidiospores can germinate and form appressoria on pear leaves, even when no symptoms occur for up to 24 days (Figure 2). Our aim is to see if these conidia can overwinter and form pseudothecia. Next to a visual

and microscopic evaluation of the infection process of *V. pirina* on pear leaves, a qPCR method will be developed to detect non-visible scab lesions. Not only leaves will be studied, but the latent presence of scab on shoots and fruits will be checked as well.

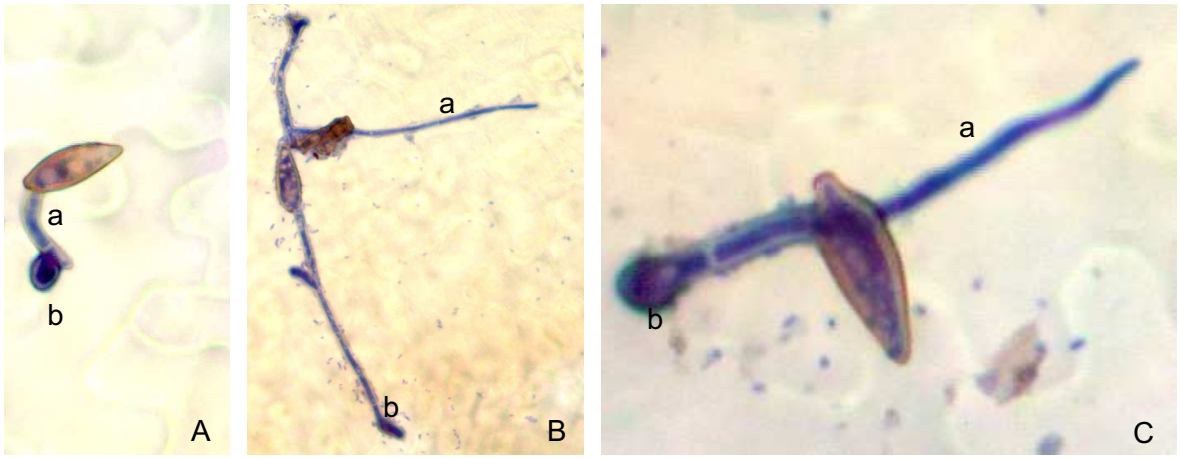

Figure 2: Photomicrographs of germinated conidia on leaves of pear seedlings (A) 24 h after inoculation, (B) 3 days after inoculation and (C) 2 weeks after inoculation with a) germ tubes and b) approsoria.

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