Fire blight shoot testing of Swiss ear Core Collection (SPCC) varieties

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Abstract

As part of the NUBIG project coordinated and carried out by FRUCTUS, 132 pear genetic resources included in the Swiss Pear Core Collection (SPCC) were tested for their susceptibility to fire blight in a shoot testing trial. The evaluation yielded first insights about the phenotypic robustness of the tested varieties, compared to the control varieties 'Harrow Sweet' (robust) and 'Passe Crassane' (susceptible). These results provide valuable information on the suitability of the varieties for cultivation and their possible use in breeding to develop new, fire blight robust pear varieties.

Keywords: pear genetic resources, *Erwinia amylovora*

Introduction

The Swiss Pear Core Collection (SPCC) comprises a collection of 155 accessions that are considered genetically valuable or of historical significance for Switzerland (Urrestarazu et al., 2019) and was planted 2019. This collection is part of the Swiss National Action Plan for the Conservation and Sustainable Use of Plant Genetic Resources for Food and Agriculture (NAP-PGREL) (https://www.blw.admin.ch/de/nap-pgrel). As part of the NUBIG (use of pear genetic resources) project, coordinated and carried out by FRUCTUS, "The Association for the Promotion of Old Fruit Varieties", 132 varieties included in the SPCC were tested for various characteristics including susceptibility to fire blight (*Erwinia amylovora)* and brown spot disease (*Stemphylium vesicarium)*. Additionally, tree health, flowering time and harvest time were evaluated in the field, fruit properties and suitability for juice production were determined by tasting and juice analysis. All results are made publicly available on the national database PGREL NIS (https://www.pgrel.admin.ch/pgrel/#/). Here, the results of the fire blight shoot testing trial will be presented. Fire blight is one of the most important diseases in pome fruit growing (Peil et al. 2009) and since it is a bacterial pathogen, the options for controlling it are very limited. Genetic robustness is the favourable strategy (Bühlmann-Schütz et al. 2023). As only few pear varieties are known to be robust to fire blight (Przybyla, et al. 2011), the SPCC is a valuable pool of pear genetic resources to screen for varieties that possess genetic robustness. For this reason, the SPCC varieties were subjected to fire blight shoot testing's in Agroscope's quarantine greenhouse.

Method

The fire blight shoot testing of the SPCC varieties was carried out following the protocol of the Agroscope apple breeding group (Bühlmann-Schütz et al. 2023), adjusted for pears. The varieties were grafted onto seedling rootstocks of 'Kirchensaller Sämling'. About 6 weeks after grafting, shoots with a preferred minimum length of 10 cm where infected artificially with *E. amylovora* inoculum (Swiss strain Ea ACW 610 *Rif*) by

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injecting the inoculum into the shoot below the leaf axil of the uppermost leaf with a syringe. The screening was carried out in the quarantine greenhouse under controlled conditions of 16-24°C and 65% humidity. After 21 days, the length of the healthy shoot was measured, and the relative lesion length (rLL) was calculated as percentage of lesion length relative to total shoot length (100%). Fire blight shoot testing was carried out in 2023, 2024 and 2025 on 58 different accessions each year, including the control varieties 'Harrow Sweet' (robust), 'Passe Crassane' (highly susceptible) and 'Conference' (susceptible). The target number of repetition was n=6 per accession, but due to dropouts and duplicates, finally was n=4 – 23 per variety. Accounting for annual variation, a relative scaled lesion length (rLL$_{sc}$) was calculated by scaling the rLL by the annual mean of the control varieties. For this, the robust variety 'Harrow Sweet' was set to 0 and the variety 'Passe Crassane', which is known to be very susceptible, was set to 100 (Bühlmann-Schütz et al. 2023). Mean values and standard deviation of rLL$_{sc}$ per variety were calculated and the data was visualized as a box plot using the R software environment (version 4.5.1, 2025-06-13 ucrt).

Results

Comparing the rLL of the control varieties, a significant difference between those varieties and between the testing years was found. 2024 stands out significantly from the other two years due to lower rLL values (Figure 1). The SPCC cultivars exhibited highly variable responses to artificial fire blight inoculation. Some cultivars, such as 'Bergamotte de Jodoigne' and 'Schweizer Heubirne', consistently showed stable low infestation across all replicates. Others, for example 'Legibirne', 'Madame Favre', and 'Baarerbirne' displayed considerable variability, as reflected by their large standard deviations. Finally, there are cultivars that regularly develop severe fire blight symptoms and perform worse in the trial than the reference cultivar 'Passe Crassane', such as 'Schweizer Bratbirne', (Figure 2). The varieties were grouped into infestation classes described in Figure 2 (internal Agroscope standard scale).
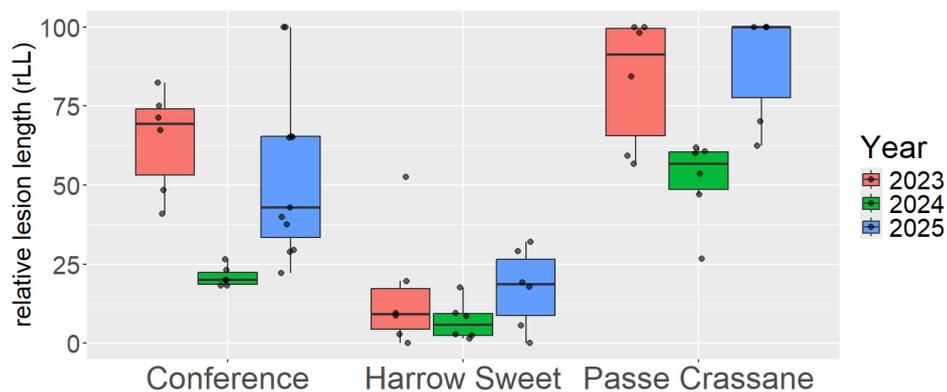

Figure1: Relative lesion length (rLL) values for the three control varieties across the three trial years (2023, 2024 and 2025).
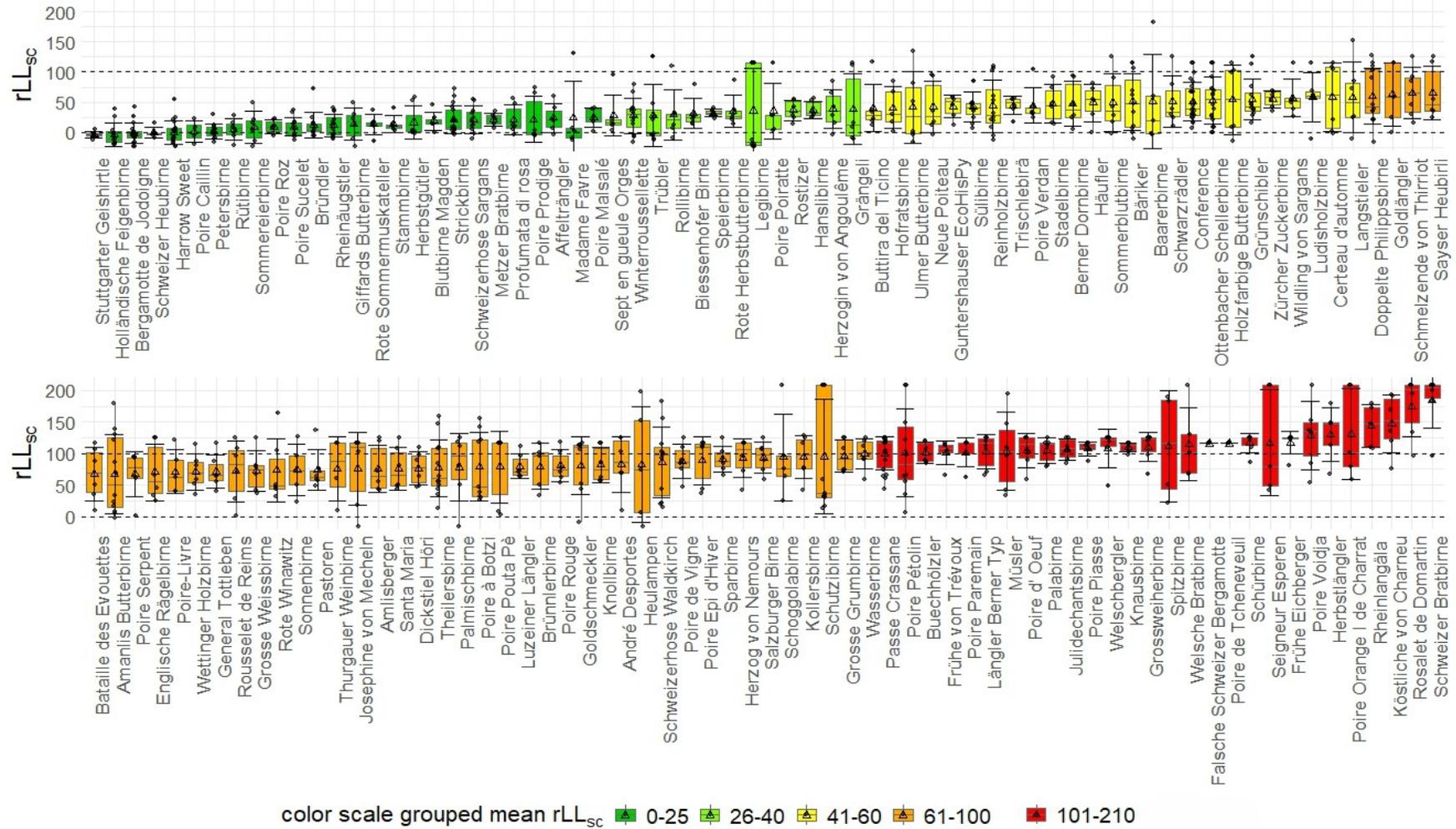
Figure 2: Boxplot displaying the distribution of the rLL$_{sc}$ values of tested varieties, combining all varieties and trial years, sorted according to the mean rLL$_{sc}$. The mean values are shown as black triangels and the standard deviation as T-lines. Individual measurement points are shown as black dots. The colour code displays grouping into infestation classes: <25% very low, 26-40% low 41-60% medium, 61-100% high, >100% very high.

Discussion

These fire blight shoot tests must be regarded as preliminary in respect of a susceptibility/tolerance verdict, as most varieties were tested only in one year. To obtain a reliable statement, tests over several years with the same genotypes should be conducted. Moreover, outdoor flower inoculation tests would be a good complementation to our greenhouse test results (Kellerhals et al. 2017). As can be clearly seen in the boxplot, the results for some varieties are more reliable, as all repetitions show similar infection levels, while the results for other varieties show considerable variation. For example, 'Legibirne' showed very minor lesions on some shoots, while other shoots were 100% infested. Why some varieties exhibit such huge variation remains unclear. Nevertheless, the genotypes grouped into a very low or low infection class and at the same time exhibit a small standard deviation are of particular interest. These varieties may contain resistance genes that could also be of interest for breeding. Some QTLs for fire blight resistance in pears are already known, but earlier studies have shown that fire blight resistance in pears (e.g., 'Harrow Sweet') is a quantitative resistance (Peil et al., 2009). It is therefore of great interest to find further sources of resistance and stronger QTLs for the development of markers (Peil et al., 2009). For this purpose, the tested varieties have already been genotyped with a 70K SNP array and will be subjected to a genome wide association study (GWAS). Regarding variety names, it should be noted that variety consolidation is an ongoing process.

Acknowledgements

References

Bühlmann-Schütz, S., Hodel, M., Dorfmann, E., Vonmetz, L., Lussi, L., & Patocchi, A. (2024). Comparison between artificial fire blight shoot and flower inoculations in apple. *Journal of Plant Pathology*,*106*(3), 903–912. https://doi.org/10.1007/s42161-023-01550-7

Kellerhals, M., Schütz, S., & Patocchi, A. (2017). Breeding for host resistance to fire blight. Journal of Plant Pathology, **99**, 37–43. http://www.jstor.org/stable/45156717

Peil, A., Bus, V.G., Geider, K., Richter, K., Flachowsky, H., Hanke, M.V. (2009). Improvement of Fire Blight Resistance in Apple and Pear. International Journal of Plant Breeding **3**(1), 1-27

Przybyla A.A., Bokszczanin K.L., Schollenberger M., Gozdowski D., Madry W., Odziemkowski S. (2012). Fire blight resistance of pear genotypes from different European countries. *Trees* (Berl West).;**26**(1):191-197. doi: 10.1007/s00468-011-0646-7.

Urrestarazu J., Kägi C., Bühlmann A., Gassmann J., Santesteban LG., Frey J.E., Kellerhals M., Miranda C. (2019). Integration of expert knowledge in the definition of Swiss pear core collection. *Sci Rep*. Jun **20**;9(1):8934. doi: 10.1038/s41598-019-44871-3