Validation of the apple scab simulator Rimpro using potted trees

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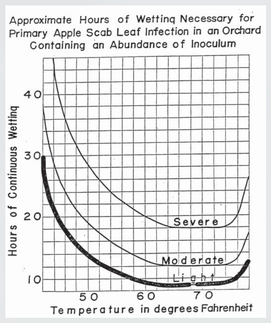
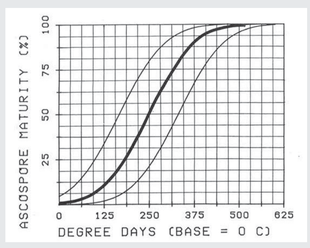
From Mills…



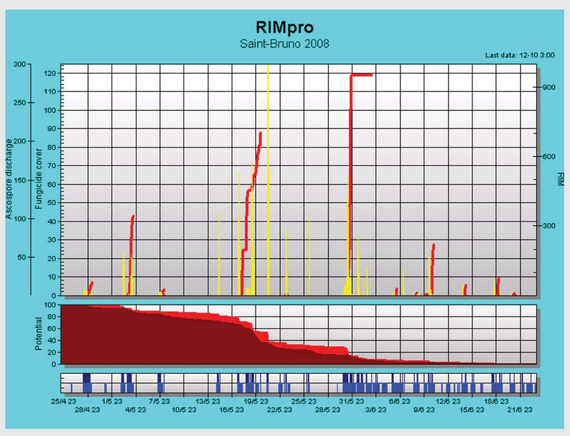
- Infection criteria only
- No provision for spore maturation
- No accounting of ejection

To Gadoury & MacHardy…



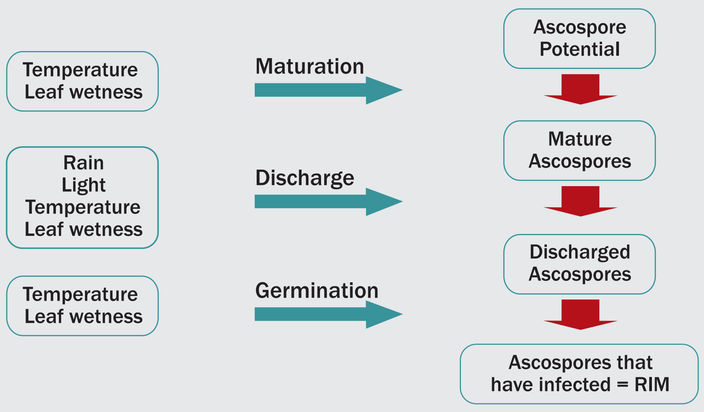
- Spore availability model
- No accounting of ejection

To RIMpro = integration



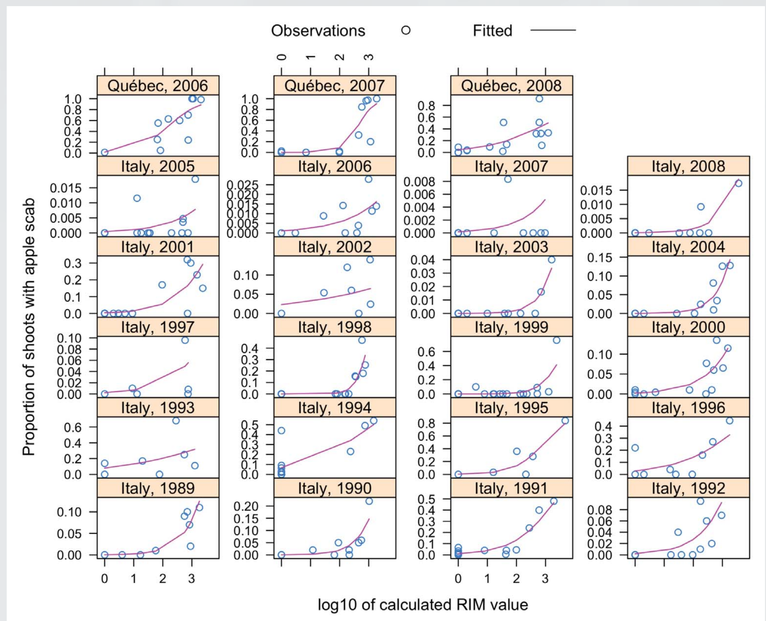
- Spore maturation = How many can shoot.
- Spore ejection = How many really shoot
- Spore infection = How many succeed
- Actual risk = RIM

RIMpro Flow Diagram



RIM validation

RIMpro



Results

- Apple scab incidence was analysed as a logistic regression in a mixed effect linear model (GLMM) using the lmer function of R(4). Year and site were set as a random intercept to account for varying inoculum levels from year to year and a random slope was used to account for year to year differences in tree susceptibility, observations, weather file source and other sources of variation. Several variables were compared as predictors of apple scab incidence. The Mill's infection criteria, leaf wetness duration, exposure duration, temperature, and combinations of the above were tested. Overall model adequacy was established by residual analysis. The selection of terms was done both using conditional F-tests (ANOVA) and with the AIC information criteria.

- In the 23 site-year dataset (Figure 1), an important range of conditions was encountered. Observed scab per exposition event varied from 0% shoot scab incidence to a maximum that ranged from 0.83% (Italy, 2007) to 100% (Québec, 2006 and 2007). Thus, the total primary scab varied greatly from year to year and was most likely a reflection of the natural overwintering inoculum levels. Because of this variation, RIMpro can only provide a relative risk assessment for a given site and year. The calculated RIM index for individual events varied from 0 to a maximum that ranged from 703 (Italy, 2003) to 4754 (Italy, 1995). The total predicted risk for a given year ranged from 1330 (Italy, 2003) to 6295 (Italy, 2001). By design, this index is a reflection of how conducive the climate is for the primary infections, notwithstanding the inoculum level present.

- Overall, the RIM value was the best single parameter for predicting scab incidence. Logit scab incidence = 1,68*log10(RIM+1) – 6,9. For RIM values of 10, 100, and 1000, the fixed effects components of the model predict 0.6, 2.8, and 13.5% shoot scab respectively. For 6 site-years, the predicted RIM values for individual events were in very close agreement with scab incidence observed on potted trees (Italy 1989, 1990, 1991, 1998, 2003, 2004). However, there seemed to be no relation between RIM and scab levels for 5 sites (Italy 1993, 1997, 2002, 2005, 2007). Most of the sites with poor correlation had very low scab incidence. Because of limits in the precision of the experiment, potted tree scab predictions are likely to be difficult under these circumstances. In general, all predictors tested also had very low fits for these sites. For 7 sites (Italy 1992, 1994, 1995, 1996, 1999, 2008, and Québec 2007) there are only one or two points that are not well predicted by the RIM value. The 5 remaining sites show a moderately adequate fit. There were 4 sites with at least one false negative prediction that showed more than 5% shoot scab incidence (Italy 1993, 1994, 1996, Québec 2008). In most cases, other predictors also made false negative predictions for these sites. It is likely that some lack of fit may be due to human error while handling the potted trees over the course of this 20-year study.

Future work

- In the next step of this project, we will compare the expected ejection intensity to volumetric spore trap data and try to identify reasons for prediction failures where possible. We have already identified that the biofix for the first available spore is a major source of error for certain years. A related project is underway to find a better criterion for setting this biofix.

Practical impacts

- The ability to predict with a reasonable level of confidence the relative scab severity of individual rain events opens the door to more tailored fungicide applications. For instance, incomplete fungicide coverage could be tolerated without consequence for rain events for which scab severity is predicted to be low, whereas events with high RIM values need perfect coverage.

Literature Cited

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