



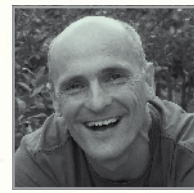
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The European Apple Scab Sandwich

Info

Apple Scab working group

For the last 19 years, a group of scientists and advisers from Europe, Canada and USA have met in January to have a two-day discussion on apple scab. Previous year experiences, observations and progress in research are discussed. The aim of the working group is to understand the system better, and to develop effective and sustainable control strategies for apple scab. Former work of the working group led to the development of the apple scab management program RIMpro. RIMpro is now used as decision support tool by more than 50 advisory teams, and several hundreds of individual fruit growers. This year, the apple scab working group met in Steiermark, Austria.

The second half of the 2011 winter was extremely mild. In Southern Europe, the first ripe ascospores of the scab fungus (*Venturia inaequalis*) were found as early as mid-February. This was more than two weeks before the bud burst of the main varieties. However, significant ascospore emissions were only detected from the start of March, which corresponds to the bud burst of the main varieties Gala and Golden in the south, and Jonagold in the northwest of Europe.

As in most years, the most significant scab infections occurred everywhere in Europe in the same weeks. This is because the ascospores are mainly emitted during weather fronts that pass over the continent. In 2011, the most significant critical phases were the last days of March, the end of April, and around 12 May. Of course, these were interspersed with some more minor local infections.

2011 an easy year?

In 2011, the second half of the winter was extremely mild. In southern Europe, first mature ascospores were already found mid February which is more than two weeks before bud break of the main apple varieties. Important discharge of ascospores was however not recorded before the beginning of March, nicely coinciding with bud break of the main varieties Golden and Gala, and with Jonagold in the northern part of Europe. As in most years, the main primary scab infections occur all over Europe in the same weeks. This is due to the fact that the main ascospore discharge periods are induced by weather fronts that pass over all of Europe. In 2011 the main critical periods occurred at the end of March, end of

April, and around May 12th. Of course, smaller local infections occurred in between.

In most production regions the infection at the end of April was a large potential risk for the growers. Since it had been dry for a long time, most ascospores were discharged on the second day of rain. As this event was correctly predicted by RIMpro, growers and advisers were able to recognize the importance of this continuing rain event, and advised the necessary 'stop' and curative treatments to their growers. Trials as well as practical observations from Italy to Belgium and the Netherlands showed that a sandwich strategy of a preventive treatment ahead of rain plus a germination window spray or a curative treatment was necessary to cope with this infection period. Where this infection event was underestimated by growers and advisers serious scab damage occurred.

Local microclimate crucial

Our discussions emphasized how the local microclimate had a crucial impact on the development of the scab epidemic in 2011. The weather stations used for infection calculations mostly represent 'average' conditions, and are sometimes not even placed in an orchard. Dew formation near riversides, in lower parts of orchards, and wood or mountain shaded areas significantly prolonged the wetness periods and allowed for infections in spring and summer that were not detected by weather stations. Accurate measurement of leaf wetness periods is always tricky. No leaf wetness sensor is 100% reliable. Models compensate somewhat by using RH measurements and VPD calculations to correct the measured leaf wetness, but this only works when stations are placed in critical rather than average orchard conditions.

The working group concluded that the limited accuracy of measurements and weather forecasts are the limiting factor for the accuracy of our infection calculations. Growers and advisers are instructed to have a critical look at the placement and maintenance of their weather stations.



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The Trojan horse

In Europe, most systemic fungicides cannot be trusted to provide good control in in each situation. The scab fungus has sequentially developed resistance to every class of systemic fungicide that was ever introduced. Reduced efficacy has been shown in both lab and field studies. For example, the reduced sensitivity to DMI fungicides in field situations did not fade away even after a 15 year interruption of the use. Additional to this development there is evidence that shows that efficacy is variable between cultivars.

Certain systemic fungicides like DMIs (e.g. Score) and anilino pyridimine (e.g. Scala) basically do not kill the fungus, but arrest further development of the fungus until leaves develop natural 'ontogenetic' resistance. Further development of the fungus is stopped by this resistance in the leaf itself, and no visible lesions occur. In autumn leaves lose their ontogenetic resistance and scab development can resume. The invisible scab infections can grow inside the leaves and form ascospores the next spring. Trials have demonstrated that DMI treated leaves showing no scab symptoms during the growing season, may produce as many ascospores as untreated leaves the following season.

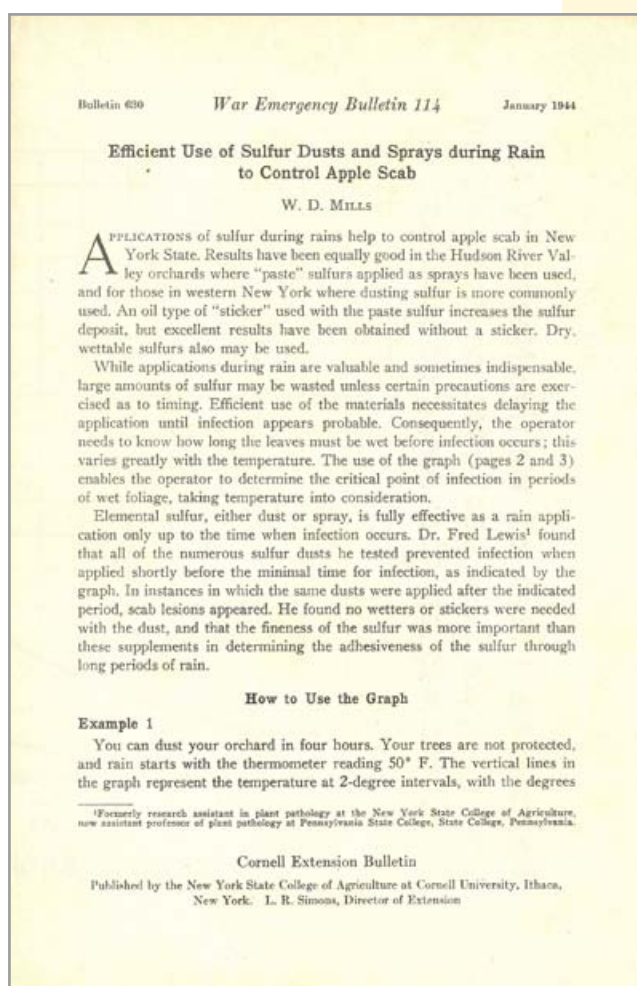
This makes that in orchards treated with systemic fungicides, the inoculum for the next spring may be completely underestimated from the visual lesions in the fall.

Back in time: germination window sprays

Germination window sprays with contact fungicides are our practical answer to resistance problems. In fact, this strategy is at least as old as the Mills table. The title of Mills paper in 1944 was "The effective use of sulfur dusts and sprays during rain". The article was not a scientific work, but a grower's bulletin. Mills stated that 'Elemental sulphur, either dust or spray, is fully effective as rain application only up to the time the infection occurs.' His publication was nothing more than a warning to his growers that the time they had

to apply their sulphur treatment was depending on the temperature.

With all our doubts about the efficacy of modern systemic fungicides, we are virtually back to this strategy of the 30's and 40's of the last century. Nowadays growers and advisers can use electronic weather stations, and integrate forecasts into their RIMpro simulations to provide growers real time information on the infection development. With this technology, germination window treatments are widely used in Europe by both organic and integrated apple growers. These window treatments are not limited to the use of sulphur. Basically all contact fungicides can be used. IPM growers prefer to use dithianon or



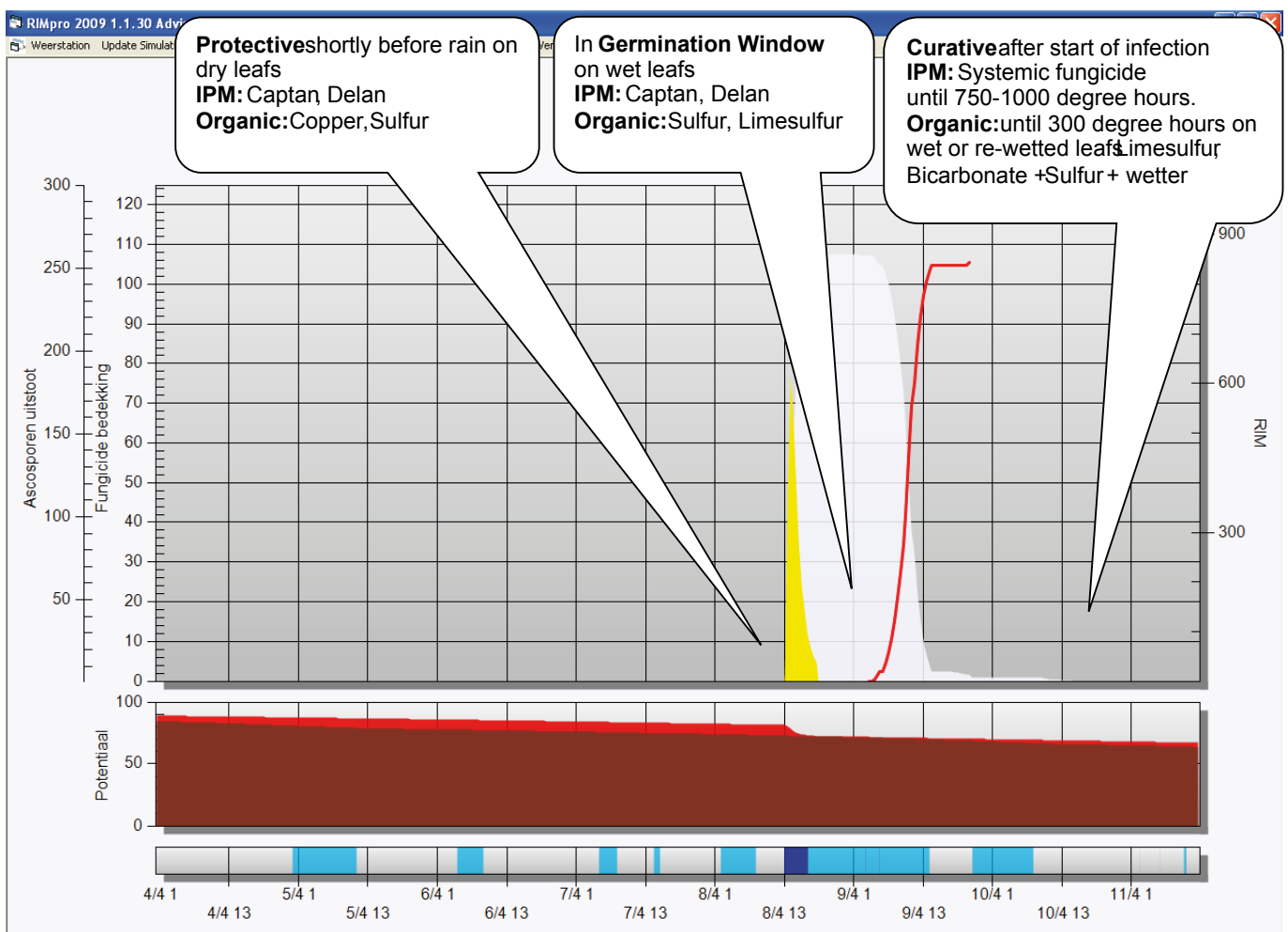
Mills paper in 1944

captan for these treatments. Organic growers choose sulphur, lime sulphur, or combinations of sulphur and potassium bicarbonate.

Sandwich Scab Strategy

For effective apple scab control European fruit growers should avoid the use of systemic fungicides as much as possible. The sandwich strategy does this by the optimal use of modern technology, and our knowledge of the mode of action of fungicides. The strategy consists in continuous awareness of the situation, and successive steps in decisions. Through practical experience we learned that for infections with RIM-values over 300, two treatments are necessary, whereas for infections with values over 900, sometimes three interventions are necessary to prevent scab infections to occur. For infections with RIM severity values below 300, a single treatment applied ahead of rain or during the rain was found to be sufficient.

1. There are **no calendar treatments**.
2. **Pre-rain preventive treatment.** When an infection event is forecasted by RIMpro, a protective treatment is advised for large orchards with over 8 hours of reaction time. When an infection with a RIM-value over 300 is forecasted, this treatment is advised for all orchards. The treatment is to be made with a well-calibrated sprayer on dry leaves, within 24 hours of the forecasted rain event.
3. **All clear.** When during the rain it is foreseen that no infection will develop, no further treatments are made, and we wait for the next forecasted rain event.
4. **Germination window treatment.** When the wetness period continues, and an infection is likely to develop, a germination window spray with a contact fungicide is advised for orchards not sprayed at step #2. If the infection is likely to develop over the RIM-value 300, all orchards are advised to be treated. This spray can be effectively applied by an orchard sprayer, or with specially laid out overhead irrigation system, on wet leaves, and should



Schematic diagram of the Sandwich method used to control scab

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be made before the penetration of the spores takes place. The real time simulation provided by RIMpro, being extended by the incorporation of local weather forecast data, helps the grower and his adviser to decide on the critical timing period. This treatment is fully effective even when applied during rain, since the germinating spores get into contact with the fungicide solution from the sprayer, the concentration of which is much higher than from redistribution by rain from a spray preventive cover spray.

5. **Stop treatment.** When the infection becomes more important than expected (RIM-values increasing over 300, or even over 900), or the infection period extends over several days, the situation gets complicated. Then we have freshly released ascospores, germinating spores, and spores that have penetrated the host plant, all at the same time. In the first 250-300 hour degrees after the penetration of the first spores (=beginning of infection), limesulfur and potassium bicarbonate can still stop the infection. Organic fruit growers will use lime sulfur or a combination of sulphur and potassium bicarbonate on wet leaves to stop the infection in the 250-300 hour degree window. Integrated fruit growers would apply combinations of contact fungicides to kill germinating spores, and add a systemic fungicide to try to stop the spores that have already penetrated the leaves.

6. **Cleaning up during on-going infections.** Infections that develop during successive days of rain do not necessarily need curative treatments. Successive treatments with contact fungicides that 'clean the leaves' from freshly discharged ascospores will do the job. Don't hesitate to spray on wet leaves or during rain. This is always better than waiting for dry weather and rely on curative chemistry.

The strategy explained above has been proven effective in our practical advisory experience, and in many trials throughout the years. It enables an effective scab control using traditional fungicides, with minimum costs, and minimum reliance on resistance threatened fungicides. The strategy is also the most efficient way to handle orchards with a high inoculum level and/or reduced sensitivity for systemic fungicides.

It requires however basic knowledge of the infection biology and mode of action of fungicides by the growers, real time infection calculations, and 24/7 support by experienced advisers. It also requires that the reaction time is not more



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than 8-10 hours, which in practice means that there should be a sprayer available for every 15-20 hectares of orchard. Where these requirements are not met, we advise to start by making alternate-row treatments over the whole farm so that at least all orchards get treated in the right timeframe. Then return asap for the second lane to complete coverage. Always starting with the orchards with the highest susceptibility and highest inoculum pressure.


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