

## EU-Project Replacement of Copper Fungicides in Organic Production of Apple (REPCO): Strategy against apple scab and results

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### Abstract

*The multifactorial REPCO-strategy to replace copper fungicides in the organic control of apple scab consisted of screening and testing of new compounds, selecting new biocontrol agents, promoting earthworms, enhancing leaf degradation, and introducing promising results into practice by experiments in commercial organic apple orchards.*

*DNA analysis and classical isolates were made of leaves infected with scab to identify new biocontrol agents against the disease. Some DNA profiles and isolates were associated with reduced ascospore production of scabbed leaves. Isolates were screened on efficacy and tested in field experiments in 2006 and 2007. A company screened the isolates for commercial purposes and formulated two of the most promising isolates. Both DNA analysis and classic phytopathological methods revealed a group of fungi with substantial efficacy and commercial interesting properties. The effect of epi- and endophytic fungi applied on apple leaves in autumn on ascospore production of *V. inaequalis* in spring showed that the best antagonist reduced ascospore production by 69% under orchard conditions.*

*Earthworms were promoted to eat more apple leaves in order to reduce the scab inoculum during winter. During three consecutive years, plots were fertilized with organic chicken manure, mulch, mushroom manure, and cattle manure. The leaf-eating earthworm species *Lumbricus rubellus* nearly doubled in number and fresh weight by fertilization with cattle manure and mushroom manure in some years, but not in other years. No effect could be demonstrated on leaf degradation.*

*Leaf degradation was further stimulated by applying fertilizers to the leaves at the moment of leaf fall. Dipping leaves in Vinasse solutions resulted in increased leaf degradation over 50% in two years and reduced production of ascospores by over 90% in 2005–6 and by 74% in 2006–7.*

*Over twenty new compounds, including several crude and commercial plant-based materials, were found that were highly effective in screening assays under laboratory and growth chamber conditions. These were further tested under small-scale field conditions. These field tests during two years demonstrated that several *Yucca* extracts substantially reduced scab. Also, potassium bicarbonate was effective. The efficacy was similar to a copper treatment in most experiments. One *Yucca* extract, as well as potassium bicarbonate, were tested in combination with 4 kg /ha sulphur under standard organic orchard conditions in an experimental orchard and at a commercial organic grower. Results from two years of field experiments confirmed that the *Yucca* extract and potassium bicarbonate treatment schedules in combination with sulphur were equally effective as the standard schedule of the fruit grower. In Denmark in 2007 an experiment showed similar efficacy to sulphur of the *Yucca* extract and potassium bicarbonate schedules, both in combination with sulphur. However, the copper treatment schedule was more efficacious. Experiments were organized at five commercial organic growers in the Netherlands in 2007. A schedule of potassium bicarbonate plus sulphur resulted in a slower development of scab at one grower, developed similarly at three other growers, and started slower but developed quicker at another grower.*

*The REPCO project resulted in finding a number of potential new compounds, *Yucca* extracts, and a formulated antagonist with high potentials for future scab control. Moreover, it is concluded that stimulating leaf degradation by Vinasse in autumn and thereby reducing apple scab inoculum is available for further development by growers. And, the use of potassium bicarbonate plus sulphur in spring might replace the use of copper fungicides in the coming years. Whole system research is urgently needed for further development and introduction in practice.*

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