# Biological control of apple scab (*Venturia inaequalis*) by *Cladosporium cladosporioides* H39

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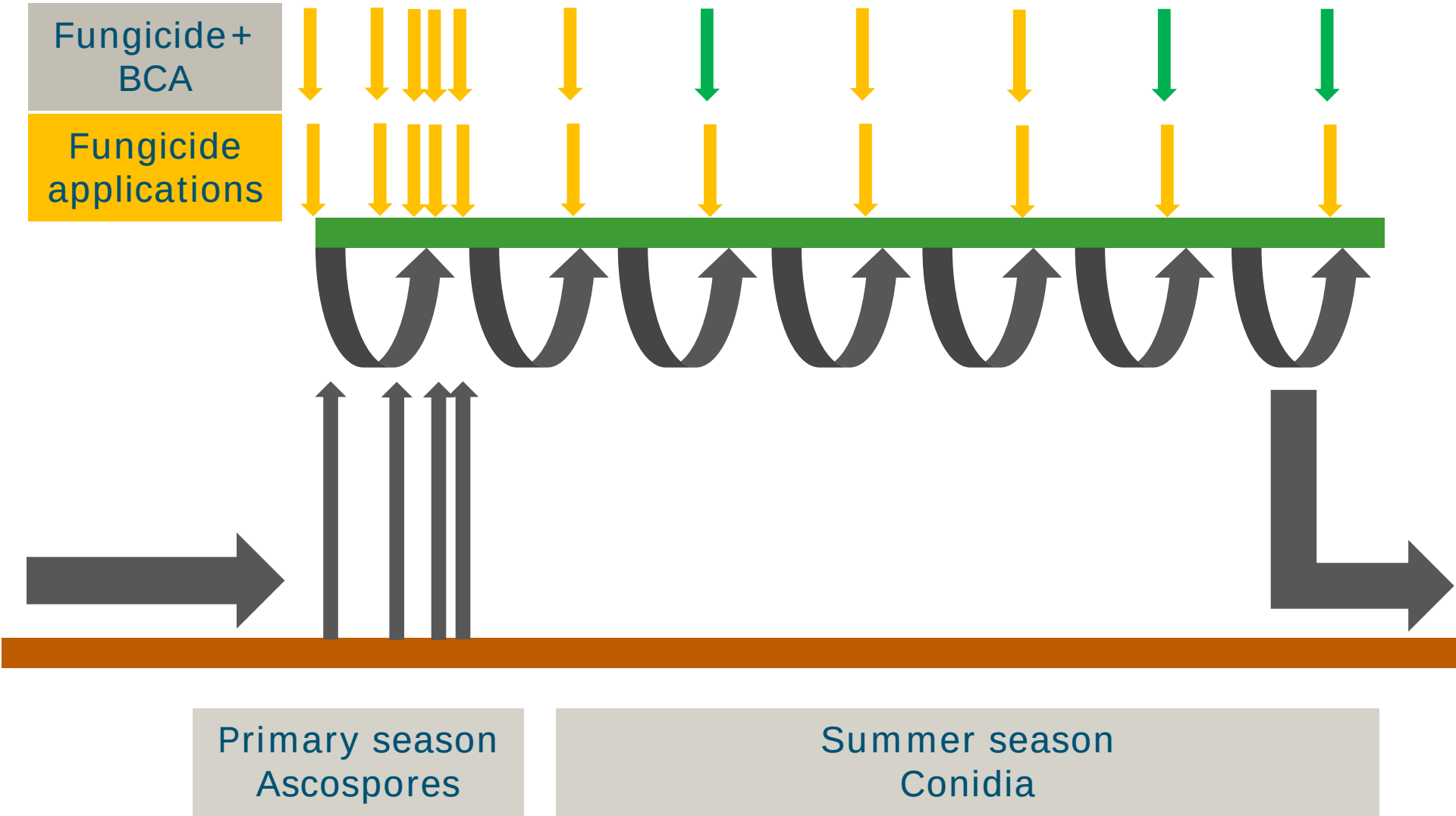
# Apple scab

# Apple scab: Life cycle and control



# Selection of a new BCA against apple scab

EU FP6
REPCO

Isolation

Pre-screening

Efficacy testing

Mass production

Field testing

*Cladosporium cladosporioides* H39

*Köhl et al., 2009. EJPP*

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# Effect of *Cladosporium cladosporioides* H39 on apple scab epidemics

9 field trials in 2012 and 2013

- Eperjeske (Hungary)
- Dabrowice (Poland)
- Bavendorf (Germany)
- Randwijk (The Netherlands)

*Köhl et al., 2014. Plant Disease*

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# Eperjeske, Idared, summer season 2012

| Treatment | Number of applications | Scab incidence (efficacy) | |
|---|---|---|---|
| | | on leaves | on fruits |
| Untreated control | - | 70.1 a | 45.2 a |
| Copper | 9 | 35.8 c (49) | 20.2 d (55) |
| H39, weekly, no formulation | 14 | 34.8 c (50) | 24.3 cd (46) |
| H39, weekly | 14 | 39.7 c (43) | 26.0 cd (42) |
| Formulation, weekly | 14 | 64.2 a (8) | 37.4 ab (17) |
| H39, 1 d after infection | 12 | 52.6 b (25) | 30.5 bc (33) |

- Stand alone calendar sprays of H39 as efficient as Cu schedule
- Formulation itself has no effect
- H39 effective if sprayed after infection

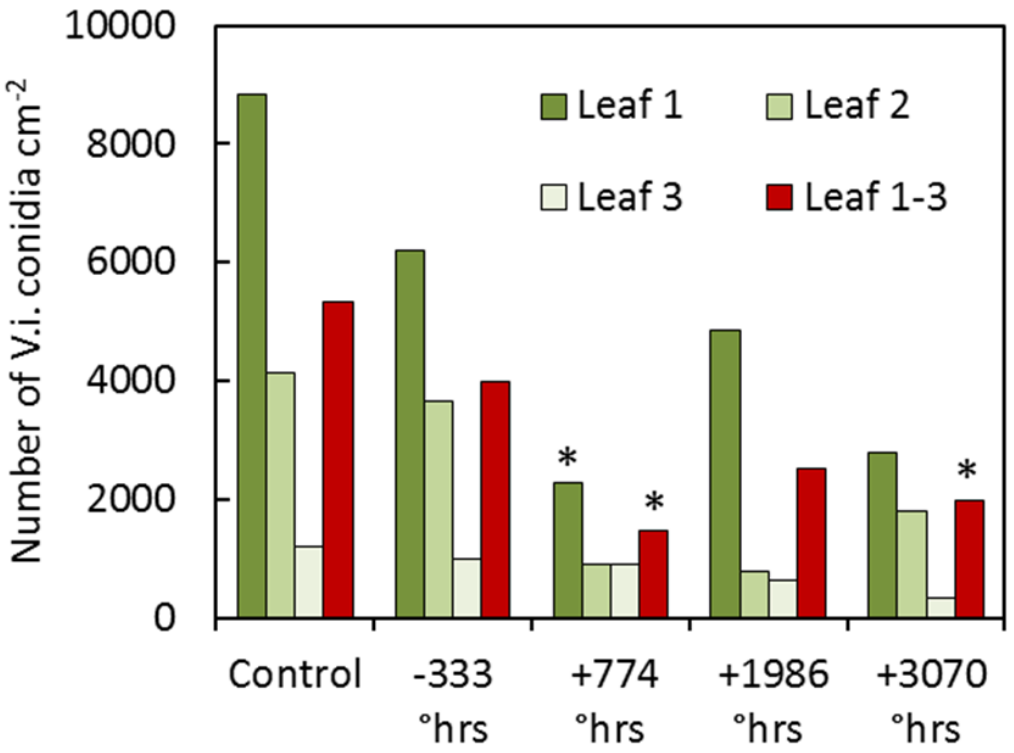
# Screening of antagonists in bioassay

- Inoculation of seedlings cv Golden Delicious with conidia of *Venturia inaequalis*
- Incubation at 15 °C, 2 days humid chamber, 2 days 85 % RH
- Inoculation with conidial suspensions of candidate antagonists
- Incubation 10 days at 15 °C
- Washing off conidia from 5 oldest leaves, counting

# Timing of H39 applications

- Randwijk, Jonagold
- Single spray of H39 on labelled leaves before or after natural Vi infection
- Assessment of Vi sporulation after 20 d for 3 leaf ages (Leaf 1 is youngest leaf)

➔ Applications after infection events are more effective

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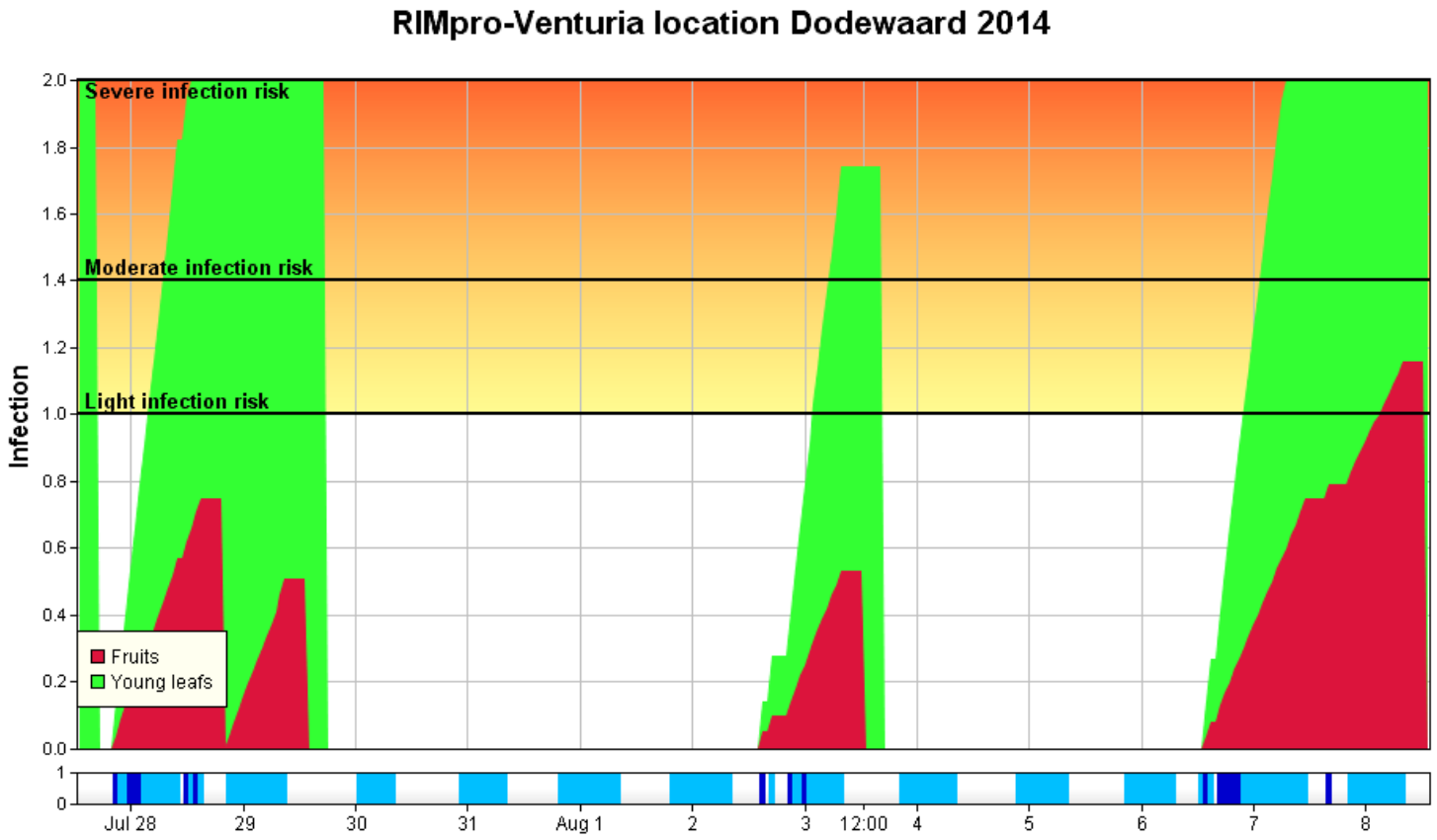
# RIMpro: Forecasting of scab infections



# Dabrowice, McIntosh, summer season 2013

| Treatment | Number of applications | Scab incidence (efficacy) | |
|---|---|---|---|
| | | on leaves | on fruits |
| Untreated control | - | 37.5 a | 26.0 a |
| H39, interval | 9 | 20.6 b (45) | 8.5 c (67) |
| H39, after infection | 4 | 37.6 a (0) | 12.5 b (52) |
| Dithianon, after infection | 4 | 15.8 b (58) | 5.5 cd (79) |
| Dithianon, after infection + H39 interval | 4 + 9 | 12.9 b (66) | 4.0 d (85) |

- H39 effective if sprayed after infection
- H39 in alternation with fungicide tends to give additive control effect

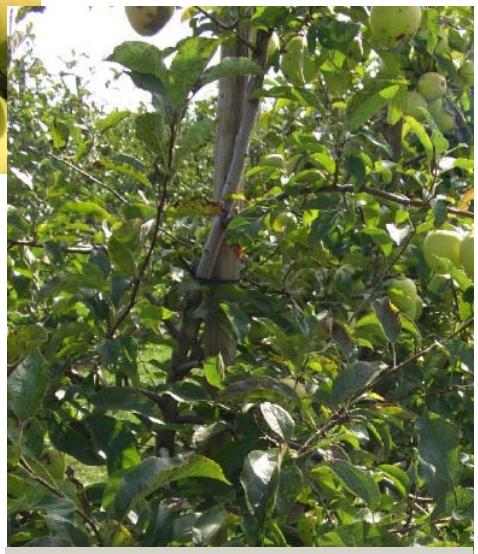
# Bavendorf, Golden Delicous, primary season 2013

| Treatment | Number of applications | Scab incidence on leaves (efficacy) | |
|---|---|---|---|
| | | 23 May | 5 June |
| Untreated control | - | 16.6 a | 49.2 a |
| Dodine, after infection | 9 | 0.0 c (100) | 1.5 c (97) |
| H39, after infection, $2x10^6$ $ml^{-1}$ | 9 | 4.8 b (71) | 22.3 b (55) |
| H39, after infection, $6x10^6$ $ml^{-1}$ | 9 | 3.9 b (77) | 19.6 b (60) |

- H39 effective during primary season if sprayed after infection

# Bavendorf, Golden Delicous, primary season, 2013

untreated control



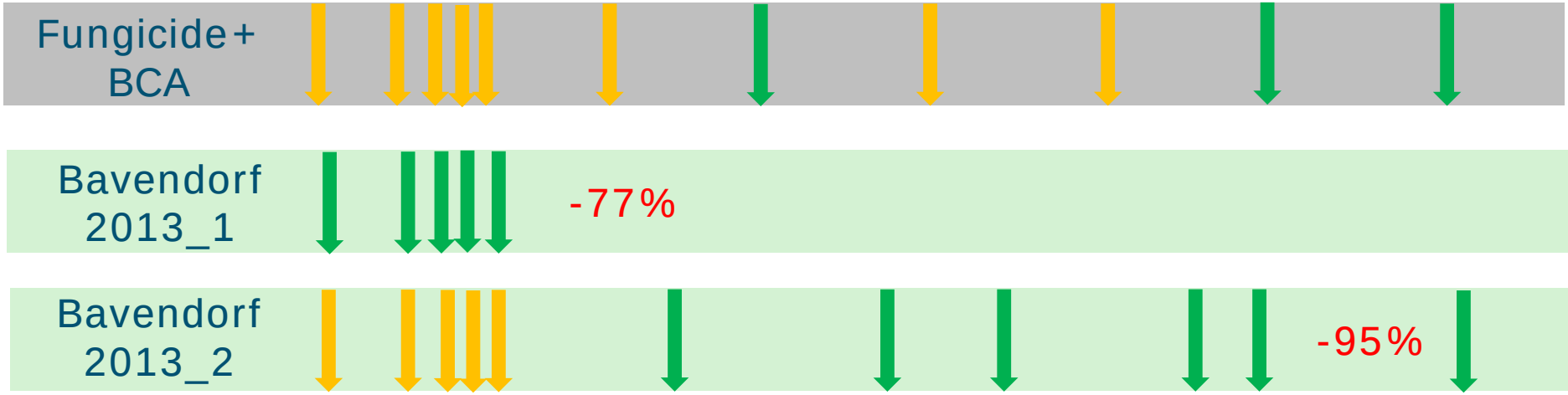
H39

# Bavendorf, Golden Delicous, summer season 2013

| Treatment | Number of applications | Scab incidence (efficacy) | |
|---|---|---|---|
| | | on leaves | on fruits |
| Untreated control | - | 17.6 a | 70.8 a |
| Dodine, after infection | 10 | 1.1 b (94) | 0.6 b (99) |
| H39, after infection, $2x10^6$ $ml^{-1}$ | 10 | 0.7 b (96) | 3.5 b (95) |
| H39, after infection, $6x10^6$ $ml^{-1}$ | 10 | 0.3 b (98) | 4.6 b (94) |

- H39 highly effective during summer season if sprayed after infection

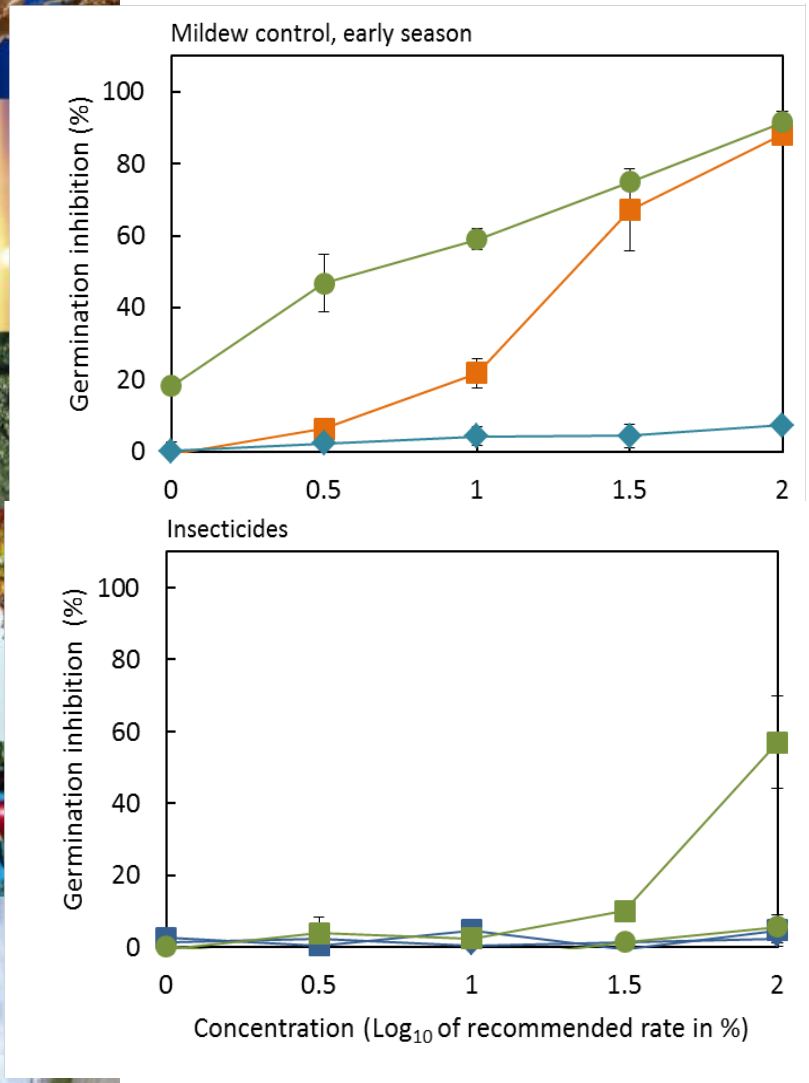
# Summary

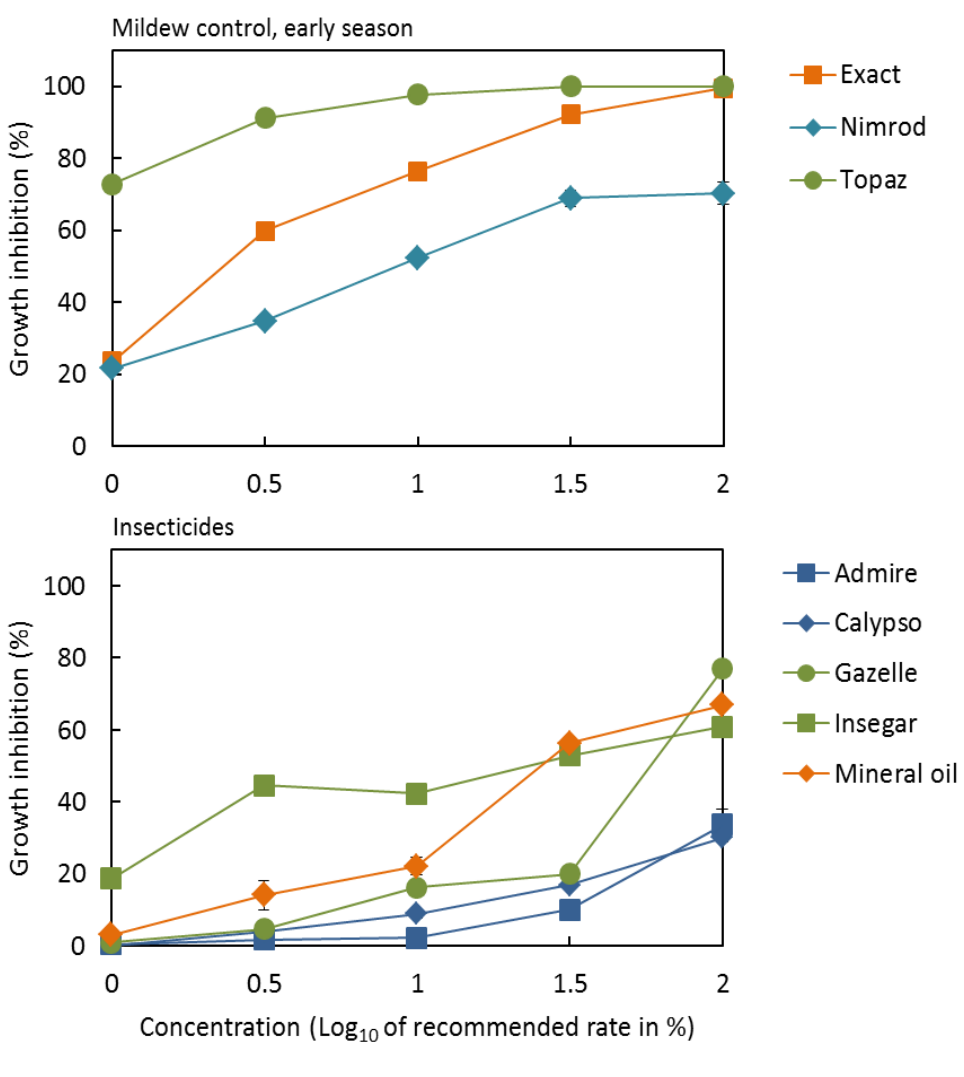



- *Cladosporium cladosporioides* H39 reduced apple scab
  - as stand alone treatment
  - during primary and summer season
  - after scab infection events

➔ Allows strong positioning in complex IPM spray schedules

# Compatibility of H39 with agrochemicals

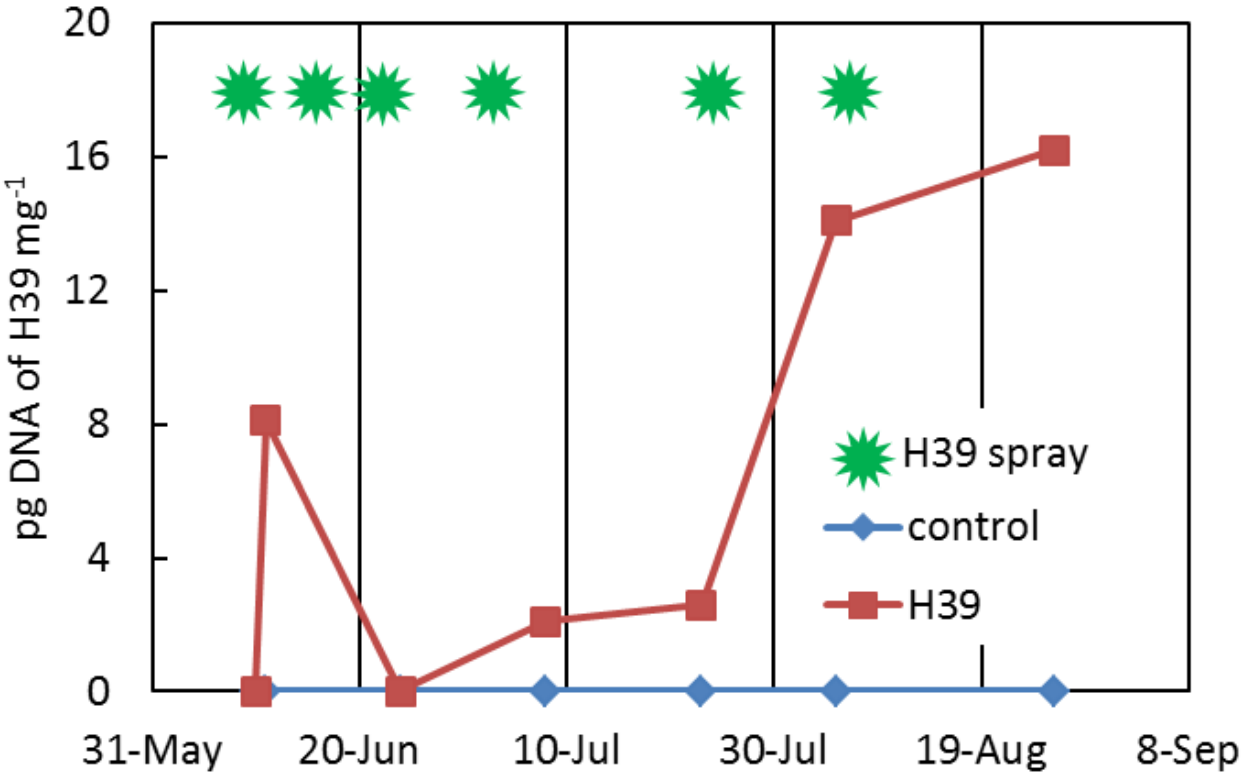


# Ongoing research:

- Transcriptomic information will be used to unravel the mode-of-action of *C. cladosporioides* H39
  - Studies ongoing
- Genomic information has been used to understand taxonomy of *C. cladosporioides* H39
- Genomic information has been used to develop strain-specific qPCR
  - Studies on population dynamics of H39 ongoing

# Monitoring H39 in the orchard



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