

The relevance of nursery plant contamination with fungicide-resistant *Botrytis* strains

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Botrytis on strawberries



Primary infection at flowering

- State of latency in receptacle of flower
- Fruit rot (primary infection) at onset of fruit ripening
- Secondary infections of further ripening fruits
- Uncontrollable epidemic

Fungicides with *Botrytis* activity

Teldor	Fenhexamid
Prolectus	Fenpyrazamin
Switch	Cyprodinil + Fludioxonil
Scala	Pyrimethanil
Frupica SC	Mepanipyrim
Geoxe	Fludioxonil
Amistar	Azoxystrobin
Candit	Kresoxim-methyl
Signum	Pyraclostrobin + Boscalid
Luna Sensation*	Trifloxystrobin + Fluopyram

* Pending registration

All 5 groups are specific fungicides → risk of resistance development!

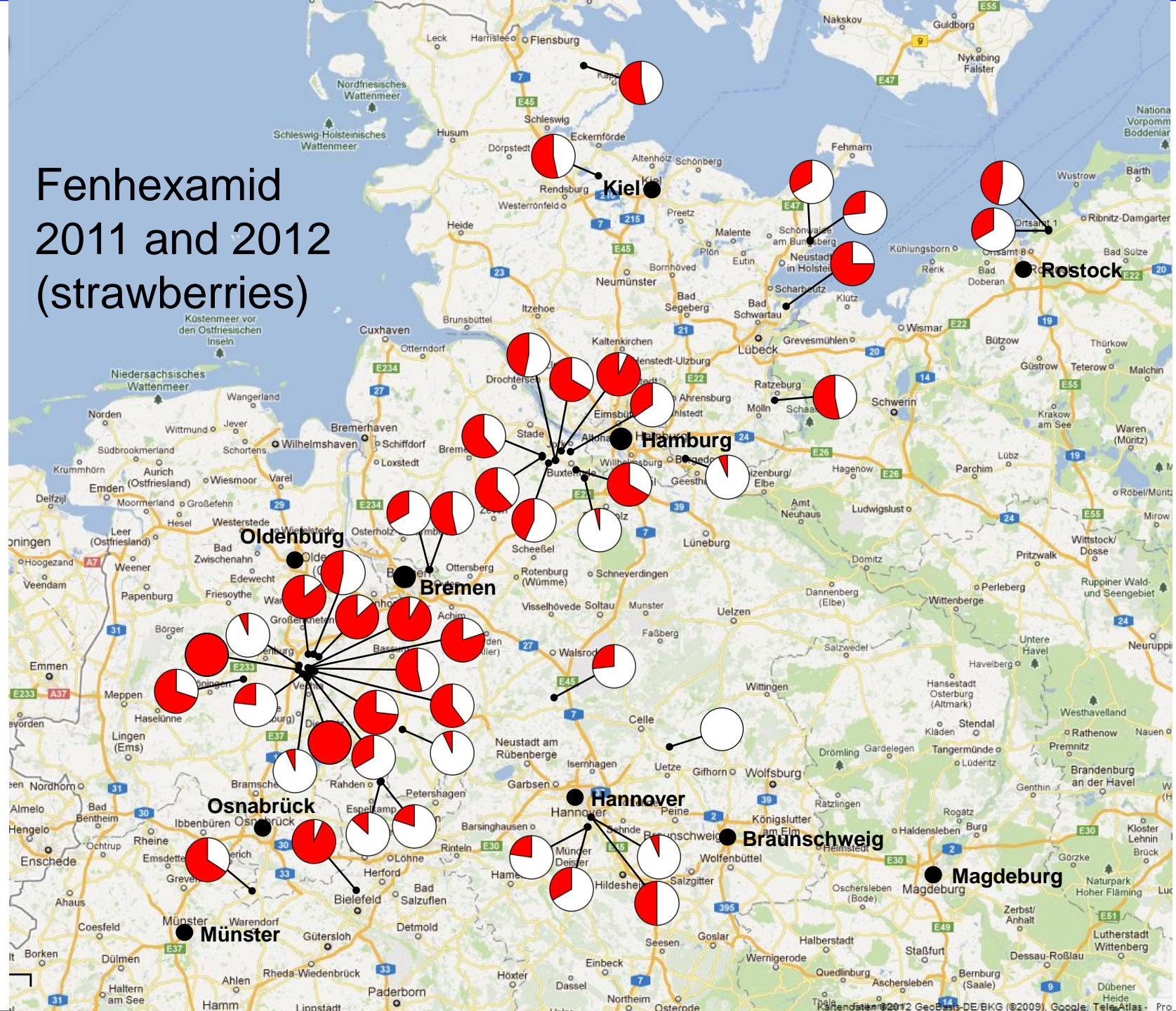
	<u>Type of resistance</u>
Hydroxyanilid	target mutation
Strobilurin / QoI	target mutation
Carboxamide / SDHI	target mutation (incomplete cross-resistance)
Anilino-Pyrimidine	target mutation and multi-drug resistance
Phenylpyrrole	multi-drug resistance only

A microscopic image showing three nematodes (roundworms) on a light gray background. The nematodes are translucent, elongated, and curved. Each has a distinct head region with a mouthpart and a tail region. They are positioned in a triangular arrangement: one in the upper left, one in the upper right, and one in the lower center.

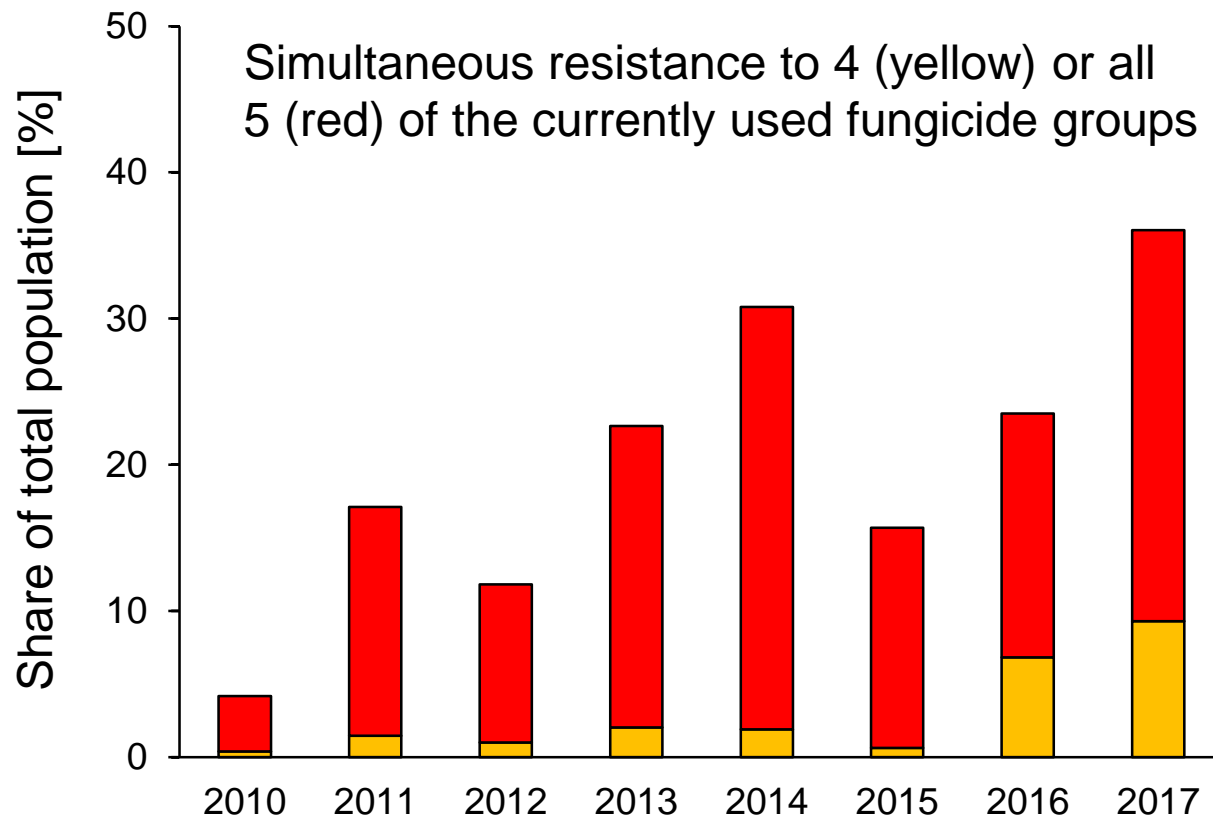
1. Basics of fungicide resistance and its management

2. First results from SprayLess

Fenhexamid 2011 and 2012 (strawberries)



Strains with multiple resistance on strawberries in Northern Germany

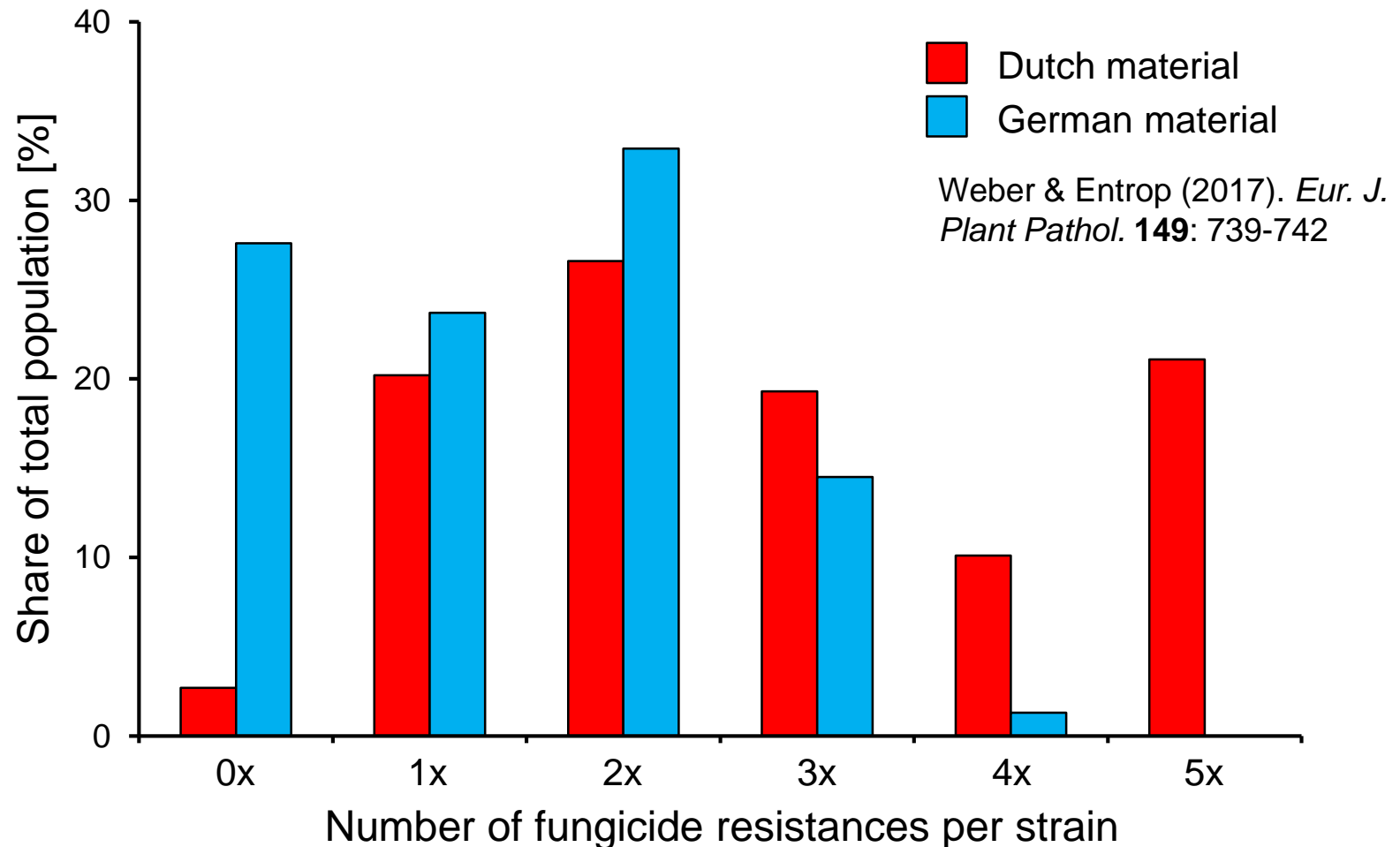


Weber & Hahn (2019) *Appl. Microbiol. Biotechnol.* **103**: 1589-1597

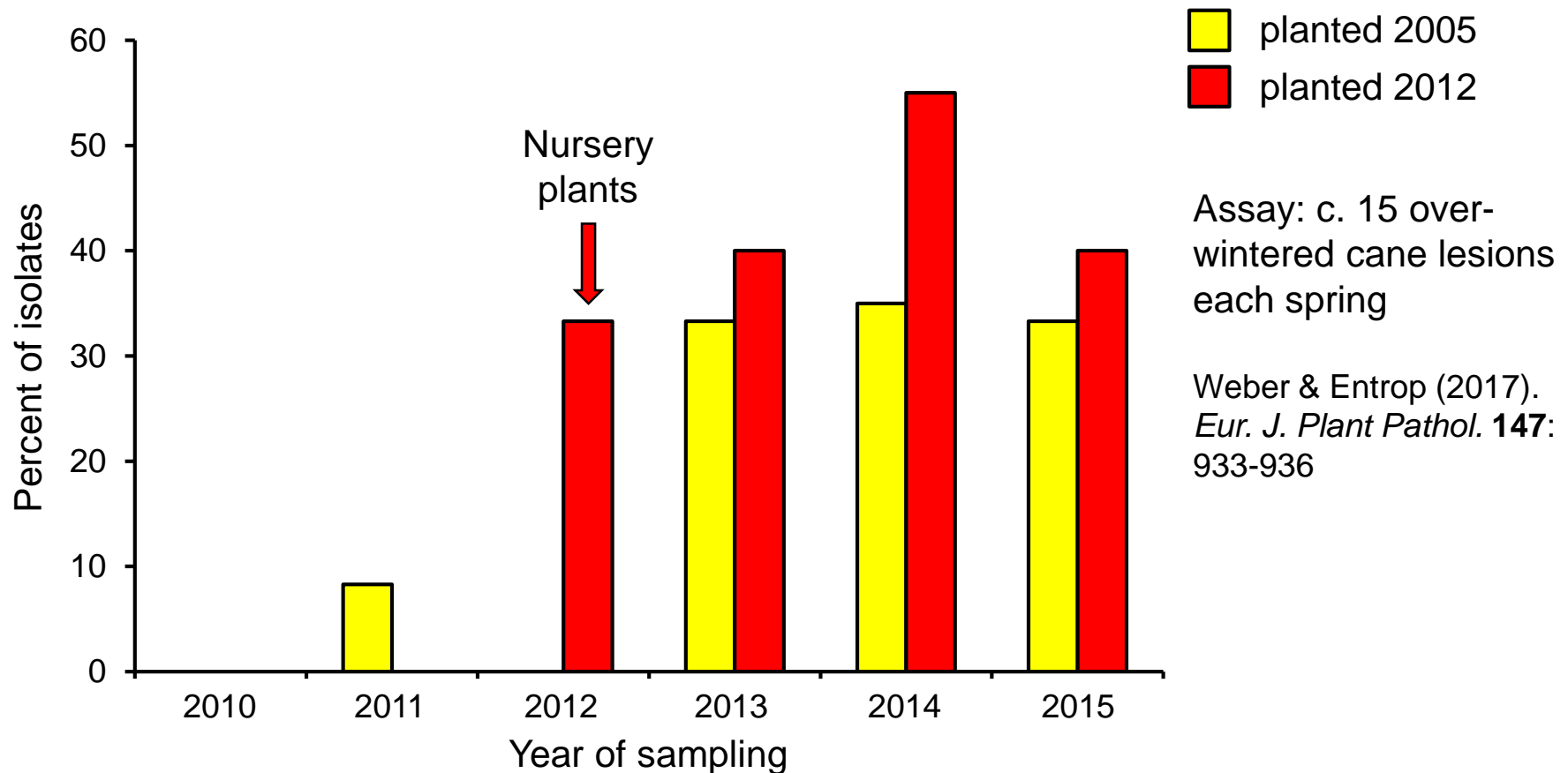
Spread of multi-resistant strains

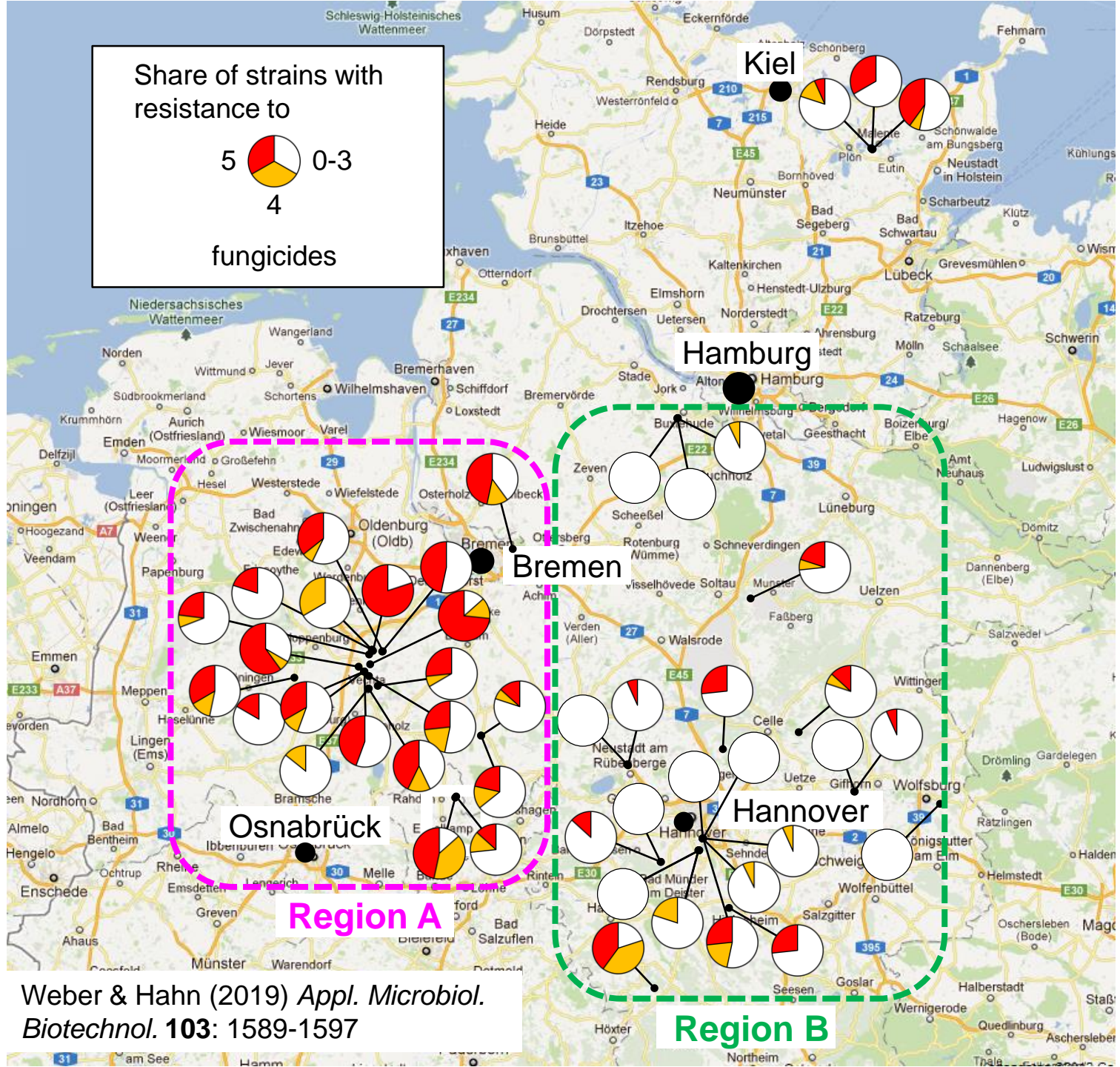
1. Stepwise acquisition of resistances to all fungicides somewhere
2. Spread by contaminated nursery material or immigration from outside
3. Local selection by intensive fungicide use

Multiple resistance in strawberry nursery material: Netherlands *versus* Germany 2014



Spread of multi-resistant strains from nursery material to an adjacent established field





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Effects of excessive spray sequences

If strains with multiple resistance are present in a field...

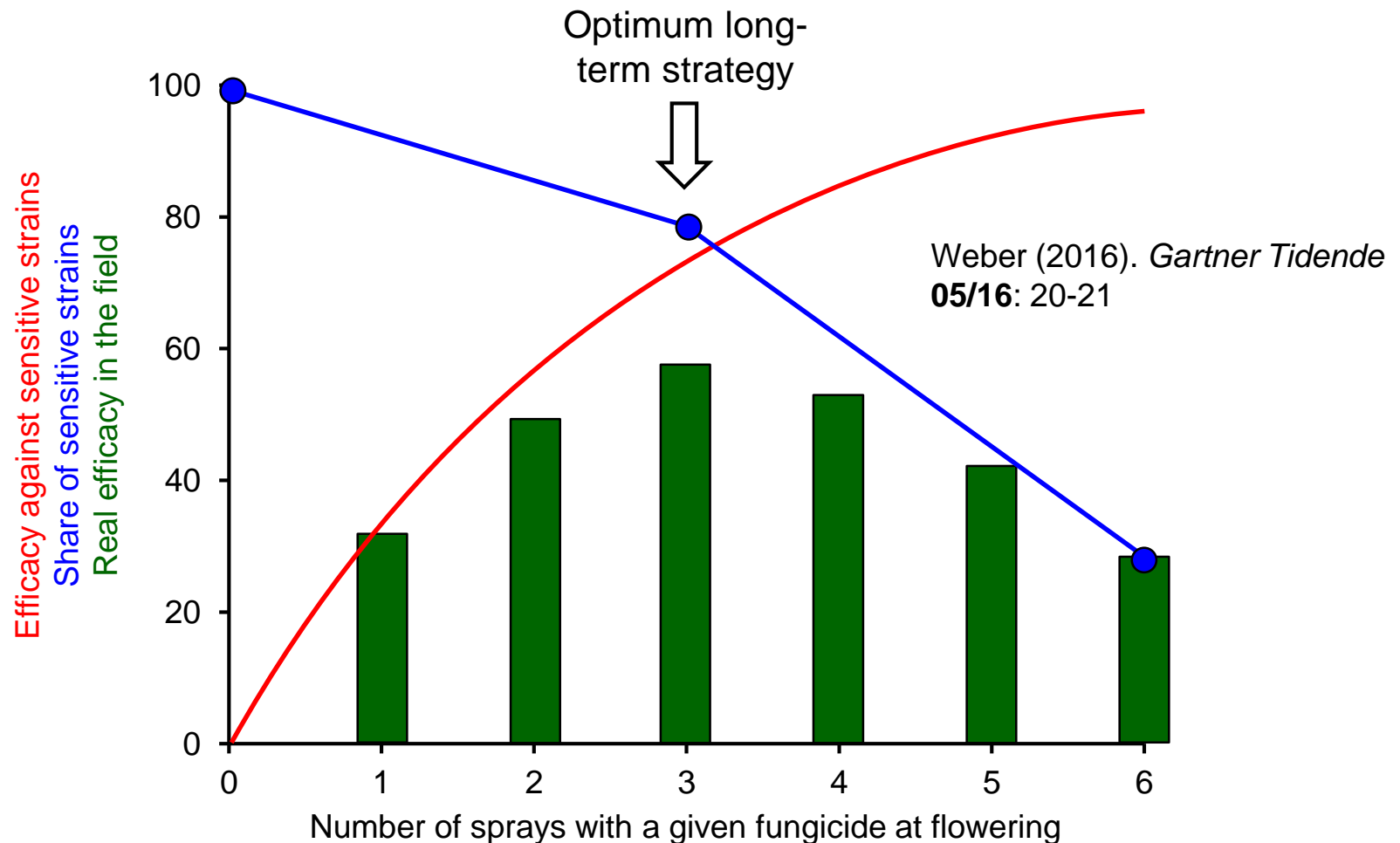
... the application of any fungicide will further select multi-resistant strains

... the more we spray, the more resistance we get

... but is the reverse also true?

A **less** frequent fungicide may reduce the selective advantage of multi-resistant strains and **means more** fungicide efficacy in the long-term

How many sprays to give the optimum efficacy?



Non-chemical control of *Botrytis*

Picking and removal of infected fruit (especially at beginning of harvest!)

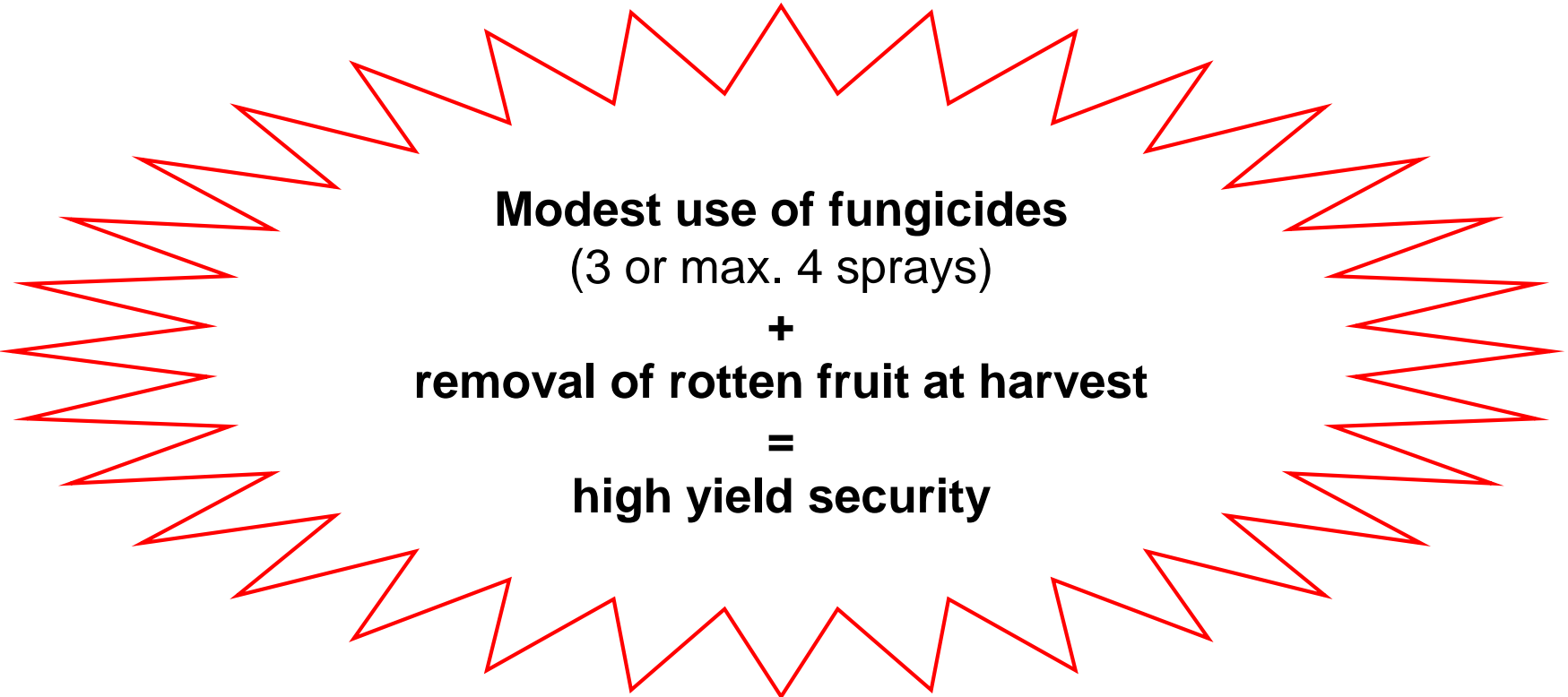
Moderate fertilisation

Sufficient planting distance

Ventilation (tunnel, protective coverings)

Drip irrigation instead of overhead irrigation





Modest use of fungicides
(3 or max. 4 sprays)
+
removal of rotten fruit at harvest
=
high yield security

- 
- A grayscale microscopic image showing three nematodes (roundworms) against a light background. The nematodes are elongated, thread-like organisms with a distinct head at one end and a tail at the other. They exhibit a wavy, curved posture. The body of each nematode is covered in small, regular transverse segments. The head region is slightly thicker and more rounded than the rest of the body. The tail is also rounded and tapers slightly from the body. The overall appearance is that of small, flexible, segmented animals.
1. Basics of fungicide resistance and its management
 2. **First results from SprayLess**

The SprayLess project

Does nursery plant contamination with fungicide-resistant *Botrytis* strains have an effect on commercial production?

- Resistance status in the field during production
- Economic loss due to grey mould

Set-up of the preliminary experiment 2018


1. Resistance test of 5 batches of strawberry nursery plants (50 plants each)
2. Planting of strawberries at Årslev Station
3. Spraying with fungicides at flowering: Signum → Switch → Teldor
4. Collection of all rotten fruit at harvest
5. Resistance test

2018 results of SprayLess project: Summary

Nursery plant status		Fruit infection at harvest	
Infection level	Share of MR strains	Infection level	Share of MR strains
low	low	low	variable
low	high	moderate	high
high	low	low	variable
high	high	high	high

Conclusions from the 2018 experiment

1. Nursery plant batches differed strongly in terms of
 - a. abundance of *Botrytis* strains
 - b. fungicide resistance of *Botrytis* strains
2. High shares of MR strains in nursery plants were perpetuated at first-season harvest, causing grey mould
3. High shares of sensitive or single-resistant strains in nursery material were controlled by fungicides



Differences at nursery stage continue
into fruit production
→ **proof of concept for the entire project**

Working hypotheses for the project and beyond

1. 50 nursery plants may be enough for a routine test to predict subsequent events
2. Nursery plant contamination with susceptible *Botrytis* strains is not important for subsequent production ...
3. ... because strains of *Botrytis* with single fungicide resistance are controlled by spray sequences at flowering
4. MR strains are not controlled by any fungicide
5. First proposal of a preliminary cut-off point: Yield security is threatened if >10 of 50 nursery plants harbour MR *Botrytis* strains



Suitable nursery material
(free from MR strains)

+

Modest use of fungicides
(3 or max. 4 sprays)

+

removal of rotten fruit at harvest

=

high yield security



Thank you!