bio-ferm GmbH

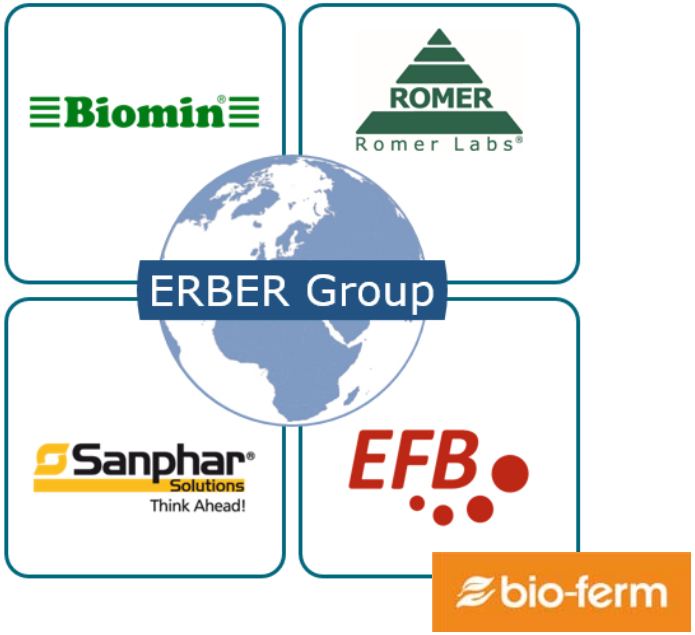
bio-ferm is part of the ERBER Group

Efficacy of microbial plant protection products

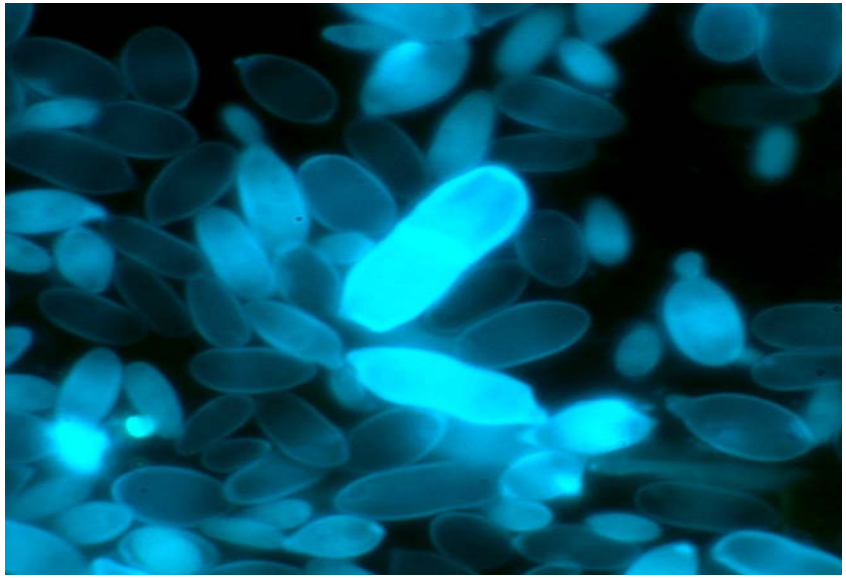
bio-ferm is part of the Austrian family-owned

ERBER Group

- more than 50 branches
- active in almost 100 countries worldwide
- more than 1.600 employees
- turnover of 250 Mio EUR



Aureobasidium pullulans, DSM 14940 and DSM 14941

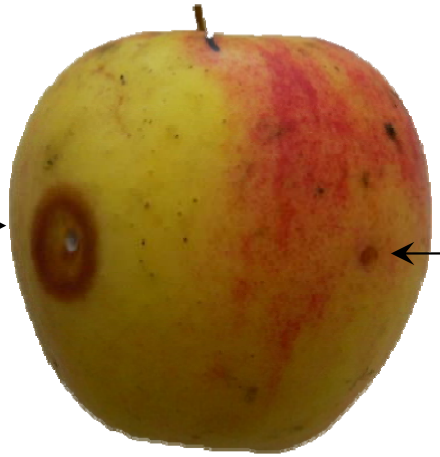


History

Screening for activity against pathogens causing storage rots in apple

(Schiewe und Mendgen 1992; Falconi 1993; Schiewe 1993; Falconi und Mendgen 1994)

Botrytis cinerea
Penicillium expansum
Monilia fructigena
Neofabraea sp. (Gloeosporium)



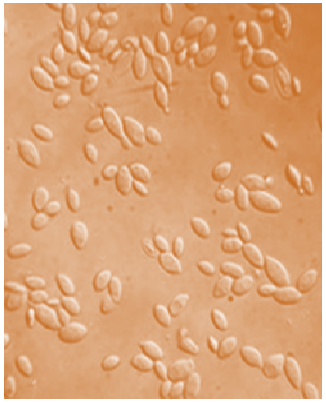
Aureobasidium pullulans

Antagonist +
Pathogen

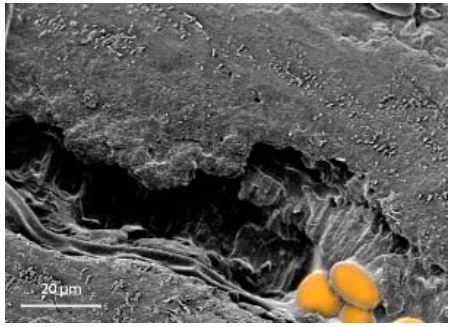
Aureobasidium pullulans DSM14940 and DSM14941

- two strains as active substances in all bio-ferm products

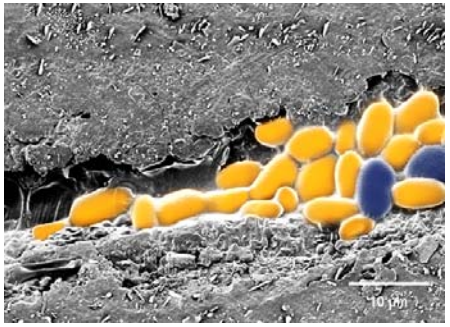
Ascomycete, asexual, yeast-like reproducing cells (blastospores)



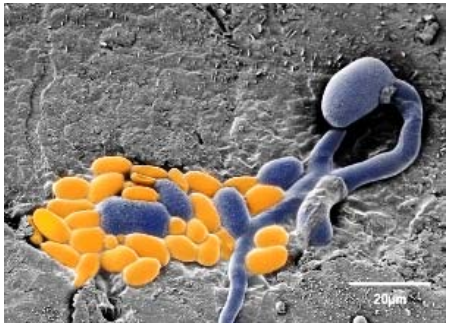
Mode of Action: Antagonism – competition for space and nutrients



1. Micro scratches on the fruit surface represent natural entrances for the pathogen. The scratches are colonized by *Aureobasidium pullulans* immediately after application of Botector® . (Picture: Mendgen).



2. Due to the high proliferation rate of *Aureobasidium pullulans* the pathogen cannot infect the plant . (Picture: Mendgen).

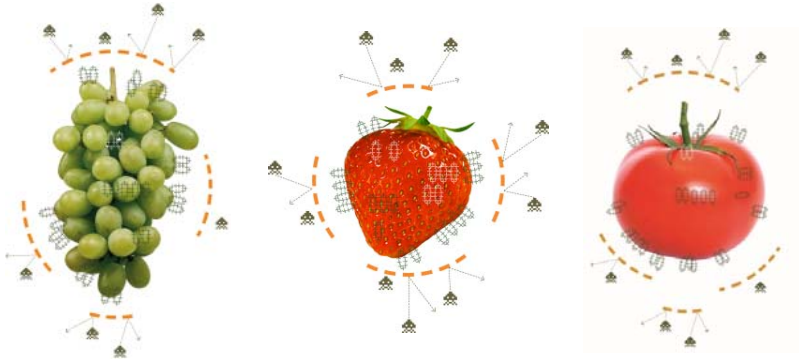


3. The micro scratch is completely colonized with *Aureobasidium pullulans*. Botector® acts as a natural shield which protects grape bunches from infection with *Botrytis cinerea* (Picture: Mendgen).

- *Aureobasidium pullulans*
- pathogen

Blossom Protect™

Botector®



Europe

< 2014 **Provisional Registrations**
(Art. 8(1) | Dir. 91/414) and
Emergency Use Permits
(Art. 53 | Reg. 1107/2009)
Final registrations (not EU)

2014-01 **EU Approval of *A. pullulans***

2014-07 **Final Registrations**
(zonal procedure, pending in
C-EU and S-EU)

Transition period:
Provisional Registrations
remain valid until final registration
(e.g. Austria, Belgium, Netherlands, Poland, Portugal…)

Emergency Use Permits

Canada
- ✓ Blossom Protect since 2012
- ✓ Botector since 2014

United States
- ✓ Blossom Protect since 2012
- ✓ Botector since 2012

Morocco
- ✓ Botector since 2009

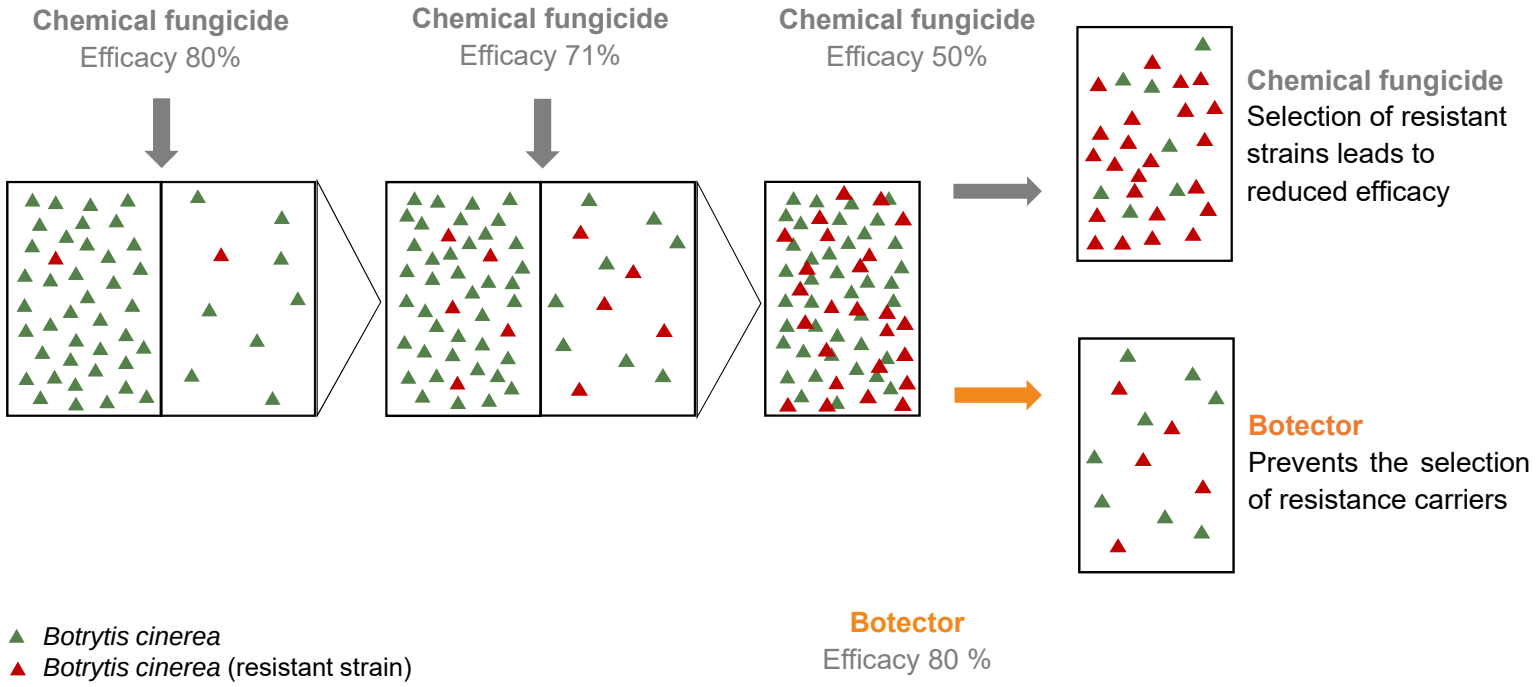
Tunisia
- ✓ Blossom Protect since 2016
  Botector *pending* since 2016

Israel
- ✓ Blossom Protect since 2017

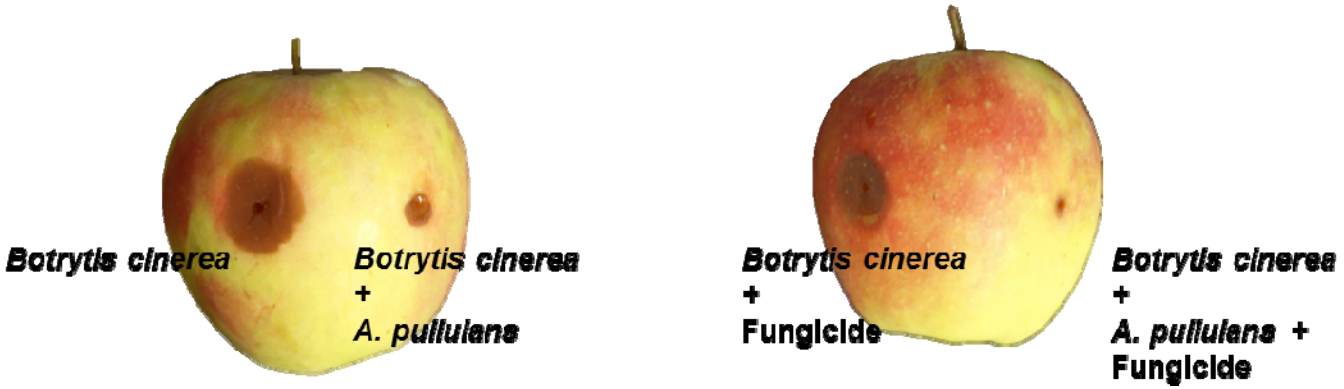
Australia
- ✓ Botector since 2017

New Zealand
- ✓ Blossom Protect *pending* since 2014

Resistances of *Botryis cinerea* to chemical botryticides



Synergistic Response



- X = % Efficacy substance A , Y = % Efficacy substance B
- Expected response of the mixture: E = X + Y –(XY/100)
- Synergistic response = Efficacy of the mixture/ Expected response of the mixture

(Colby SR, 1967. Calculating synergistic and antagonistic responses of herbicide combinations. *Weeds* **15**, 20–22.)

Synergistic response

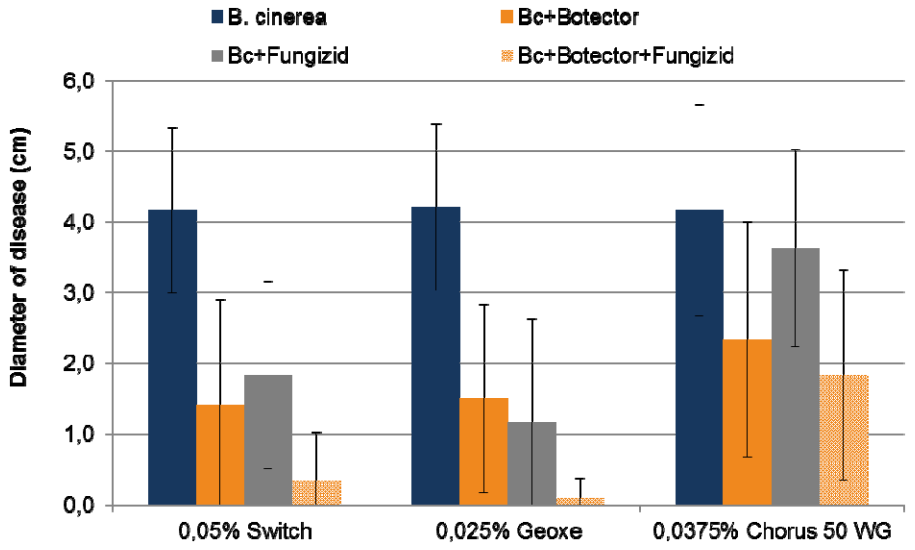
Aureobasidium pullulans (Botector) against *Botrytis cinerea* Bc97

Bc97, multiresistant

to Strobilurin, Boscalid,

Cyprodinil, Fluopyram

and reduced sensitivity to Fludioxinil



ANOVA; Tukey Multiple Comparison Test	A	BC	B	C		A	B	BC	C		A	B	AB	B
Efficacy (%)		66	56	92			64	72	98			44	13	56
Synergistic response				1.1					1.1					1.1

Blossom Protect™ + Buffer Protect™ – application against fire blight

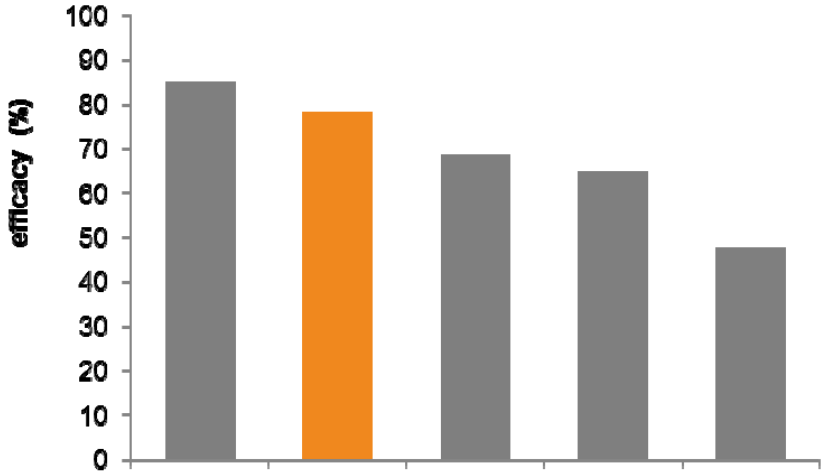
Dose	Kg/ha ground area (2m canopy height)	Kg/ha ground area per m canopy height	Kg/ha leaf wall area	Kg/hL %
Blossom Protect	1.5	0.75	1.25	0.15
Buffer Protect	10.5	5.25	8.75	1.05
Blossom Protect + Buffer Protect	12	6	10	1.2

- 1-5 applications during bloom (BBCH 61-67)
- Use the same equipment and volume as for e.g. scab fungicides

- Spray volume: 200 – 1.000 l/ha
- Clean tank before use
- Use spray suspension within 8h

Blossom Protect™ + Buffer Protect

Germany, 2003-2016, published trials

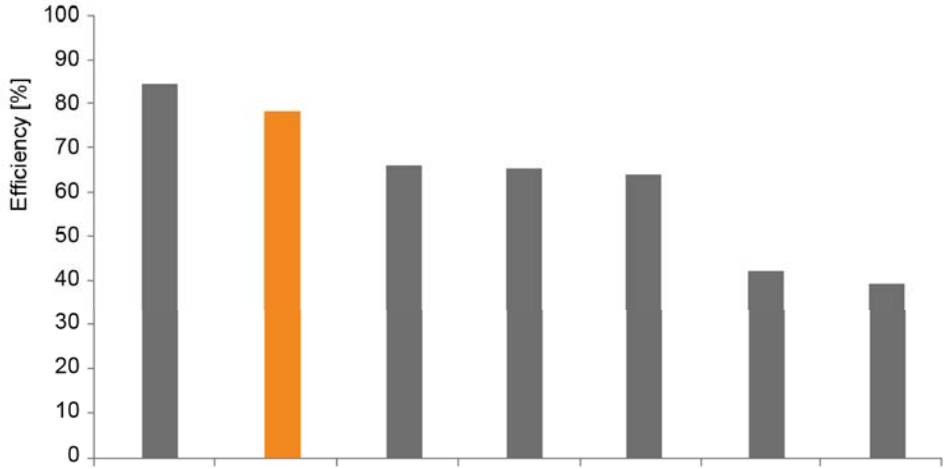


	Streptomycin	Blossom Protect +Buffer Protect	potassium-aluminium-sulfate	acidic stone dust	*Bacillus* spp
No. of trials	7	19	3	5	8

Sources: Fr ed A (1997), *Obstbau* 22(12):598-602. Fried A et. al (2004) , *Obstbau* 29(3):161-164. Kunz S et. al (2004), *Ökoobstbau* (4): 2-7. Jelkmann W (2006) *Jahresbericht der BBA 2005*). Kunz S et. al (2006) , *Ökoobstbau* (4): 3-7. Fried A (2007), *Obstbau* 32(4):204-208. Scheer C et. al (2007), *Obstbau* 32(4):199-202. Kunz S et. al (2008), *13th Ecofruit* (FÖKOe.V., Weinsberg), pp 299-305. Kunz S et. al *14th Ecofruit* (FÖKOe.V., Weinsberg), pp 118-125. Kunz S et. al (2011) *Acta Horticulturae* 896:431-436. Knaus C & Joseph C (2012), *Infodienst Weihenstephan* Ausgabe Juli 2012. Kunz S (2012). *Obstbau* 4/2012(4):217-220. Fried A (2014), *Obsbau* 3/2014(3):134-136. Fried, A, (2016), pers communication

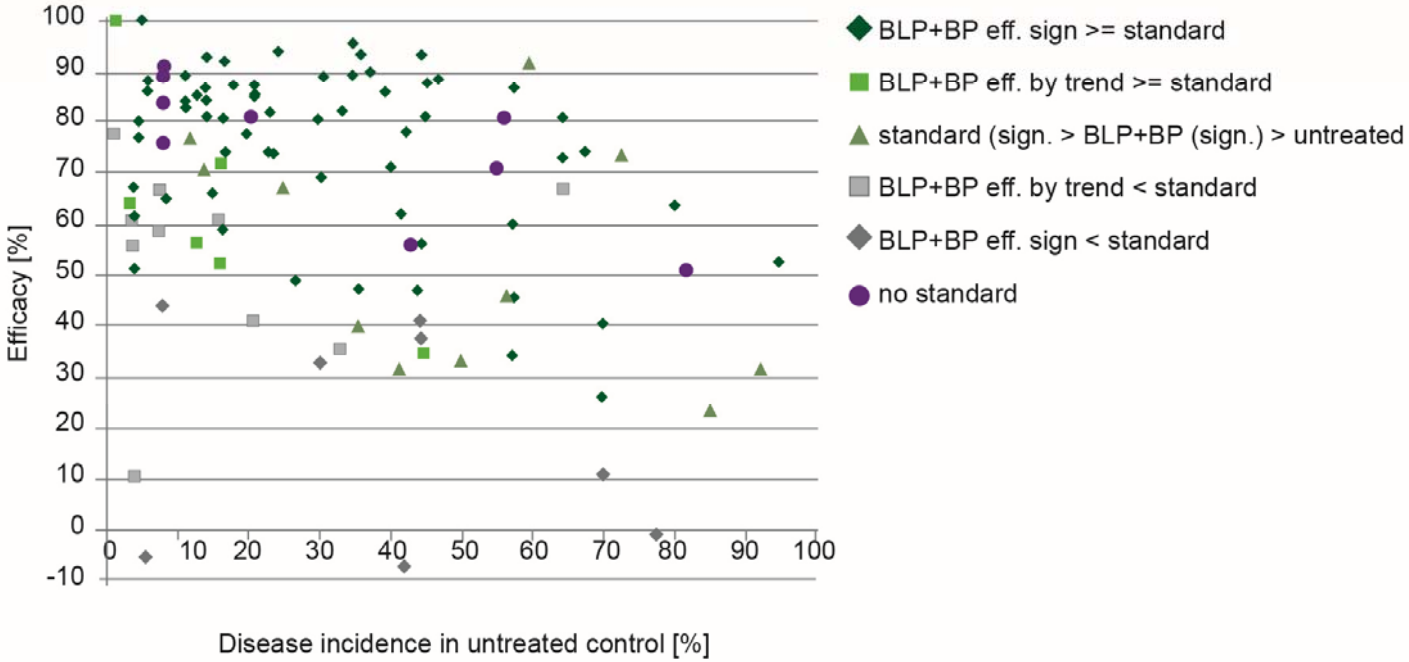
Blossom Protect™ + Buffer Protect

USA, 2008-2016 apple and pear, Trials with Blossom Protect (in courtesey of Westbridge Agricultural Products)



	Strepto-mycin	Blossom Protect + Buffer Protect	Oxyte tracyclin	Copper-hydroxide	Kasu-gamycin	*Pantoea agglo-merans*	*Bacillus subtilis*
No. of trials	27	37	14	6	9	6	10

Blossom Protect + Buffer Protect
Fire Blight control in 116 trials



Blossom Protect™ – application against storage diseases

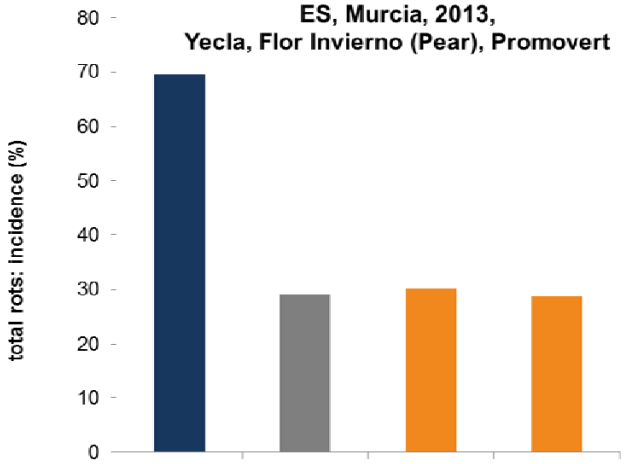
Dose	Kg/ha ground area (2m canopy height)	Kg/ha ground area per m canopy height	Kg/ha leaf wall area
Blossom Protect	1	0.75	

- 1-4 treatments starting 5 weeks before harvest (BBCH 81-89)
- Use the same equipment and volume as for e.g. conventional fungicides

- Application beween pickings possible/ no preharvest intervall
- Tank mixtures with Calciumchloride fertilizers are recommended
- Please keep a spraying interval of min. ± 3 days to incompatible products
- Clean tank before use
- Use spray suspension within 8h
- Pre harvest applications can be combined with different storage techniques (cold storage, CA, ULO, DCA, MCP-1)

Strategies:

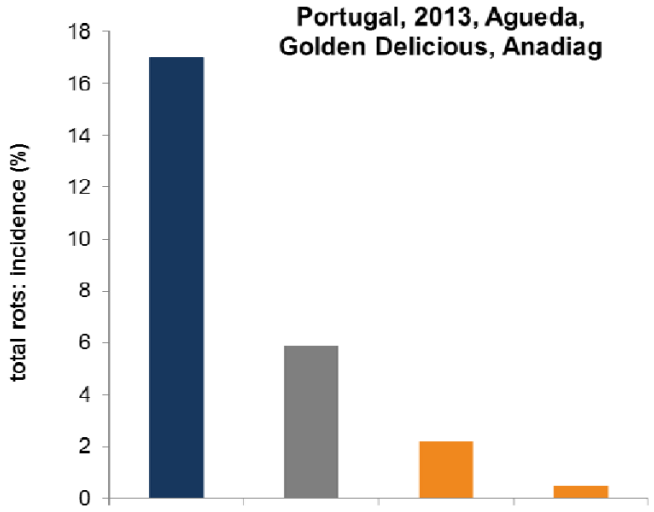
- Replacement of chemical fungicides
- In addition to chemical fungicides
- ➢ strategies using Blossom Protect after fungicides were most effective



Efficacy		-	58	57	59
Significance		a	b	b	b
BBCH 85	14.08.2013	-	-	BLP	-
BBCH 85	21.08.2013	-	REF	-	REF
BBCH 85	28.08.2013	-	-	BLP	BLP
BBCH 85	04.09.2013	-	REF	-	-
BBCH 87	11.09.2013			BLP	BLP
Harvest	18.09.2013	CA storage			
final evaluation	23.04.2014				

	application rate	active substance
REF	1kg/ha	cyprodinil+fludioxinil
BLP	1kg/ha	*Aureobasidium pullulans*

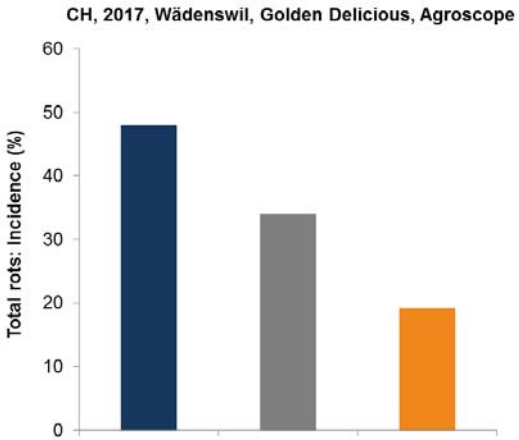
pathogens: *Glomerella* sp., *Botrytis cinerea*, *Penicillium expansum*



Efficacy		-	65	87	97
Significance		a	b	b	b
BBCH 75	09.08.2013	-	-	BLP	-
BBCH 76	23.08.2013	-	REF	BLP	REF
BBCH 78	05.09.2013	-	REF	BLP	BLP
BBCH 79	10.09.2013	-	-	-	BLP
Harvest	13.09.2013	CA storage			
final evaluation	13.03.2014				

	application rate	active substance
REF	1kg/ha	boscalid+pyraclostrobin
BLP	1kg/ha	*Aureobasidium pullulans*

pathogens: *Botrytis cinerea*

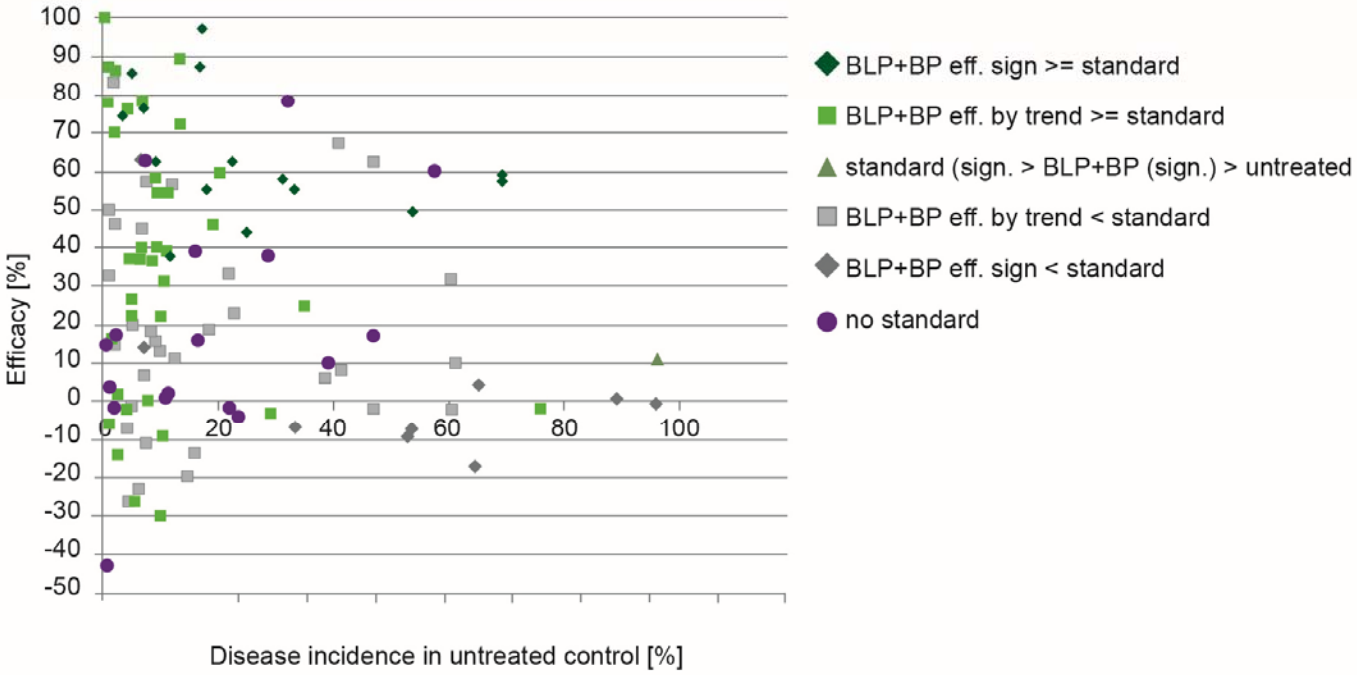


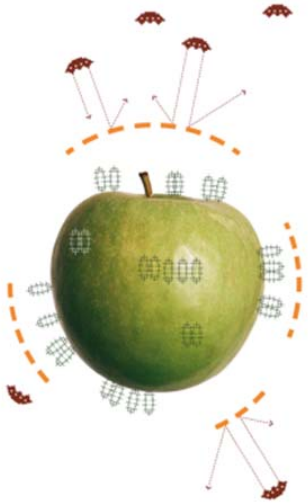
Efficacy		-	29	60
Significance		a	b	c
	22.08.2017	-	REF1	REF1
	29.08.2017	-	REF1+REF2	REF1+REF2
	05.09.2017	-	-	BLP
	20.09.2017	-	-	BLP
Harvest	22.09.2017	cold storage		
	01.06.2018	Evaluation		

	Conc. (%)	active ingredient
REF1	0.125	Captan
REF2	0.015	Trifloxystrobin
BLP	0.15	*Aureobasoidium pullulans*
main pathogens		*Neofabraea* spp.; *Botrytis* spp.

Blossom Protect

Control of storage rots in pome fruit 118 trials





Botector® – application against *Bortytis cinerea* in grapes

Dose	Kg/ha ground area, whole canopy	Kg/ha ground area, bunch zone	Kg/ha leaf wall area
Botector	1	0.4	

- 1-4 treatments (BBCH 68-89)
- Use the same equipment and volume as for e.g. conventional fungicides

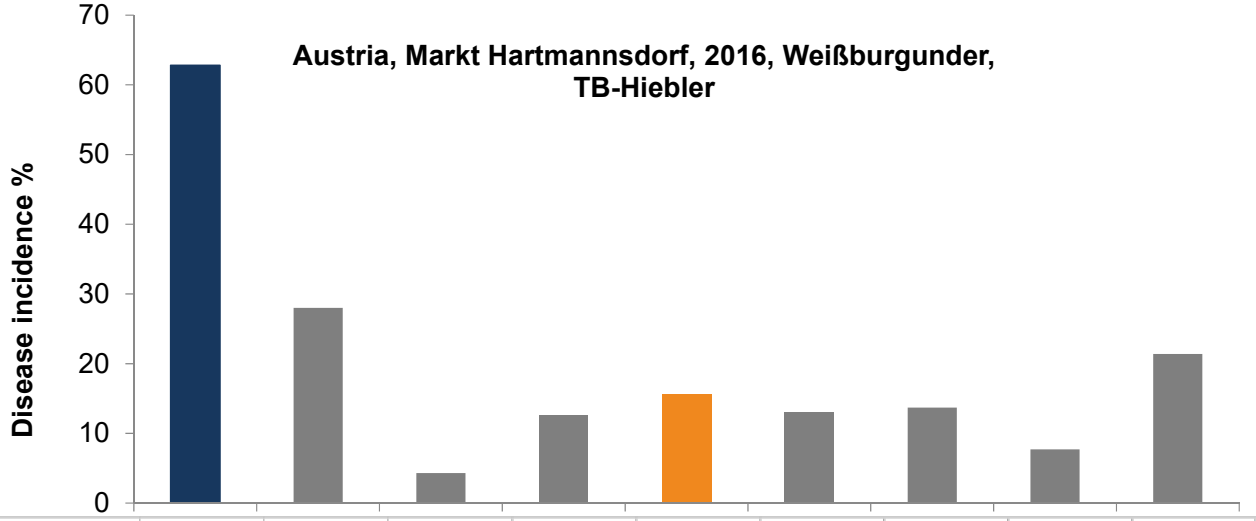
- Thorough and even coverage of the bunches is crucial
  -> remove leaves in the bunch zone moderately
- Please keep a spraying interval of min. ± 3 days to incompatible products
- Clean tank before use
- Use spray suspension within 8h

Strategies:

- Replacement of chemical fungicides
- In addition to chemical fungicides

Botector®

Field Trial: Austria, 2016
Comparison of chemical standards and products registered for organic production



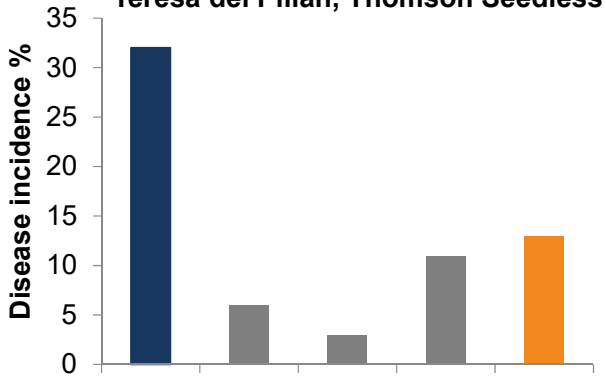
Efficacy	-	55	93	80	75	79	78	88	66
Significance	a	b	e	cde	cd	cde	cde	de	bc
BBCH 68	-	STD1	STD2	STD3	BOT	STD4	STD5	STD6	STD7
BBCH 77	-	STD1	STD2	STD3	BOT	STD4	STD5	STD6	STD7
BBCH 83	-	STD1	STD2	STD3	BOT	STD4	STD5	STD6	STD7
BBCH 85-89	-	-	-	-	-	-	-	-	-

	active substance
STD1	Cyprodinil/Fludioxonil
STD2	Fenhexamid
STD3	$KHCO_3$
BOT	*A. pullulans*
STD4	Boscalid
STD5	Pyrimethanil
STD6	Fenpyrazamine
STD7	Folpet

Botector®

Efficacy table grapes – ANASAC Chile
2013/14 Laboratorio de Patología Frutal, Universidad Católica de Chile

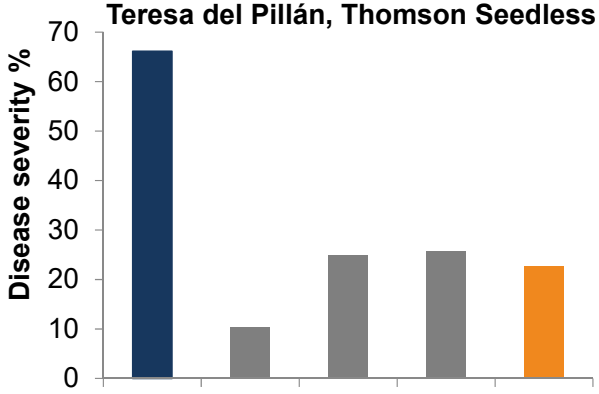
Chile, Nancagua, 2013-14, FundoSanta Teresa del Pillán, Thomson Seedless



Efficacy	-	81	91	66	59
Significance	d	ab	a	bc	bc
BBCH 69-71	-	CH1	CH2	CH3	BOT
BBCH 75	-	CH1	CH2	CH3	BOT
BBCH 83	-	CH1	CH2	CH3	BOT
BBCH 87	-	-	-	-	-

- Evaluation after harvest

Chile, Nancagua, 2013-14, FundoSanta Teresa del Pillán, Thomson Seedless



Efficacy	-	84	62	61	66
Significance	d	abc	bc	bc	bc
BBCH 69-71	-	CH1	CH2	CH3	BOT
BBCH 75	-	CH1	CH2	CH3	BOT
BBCH 83	-	CH1	CH2	CH3	BOT
BBCH 87	-	-	-	-	-

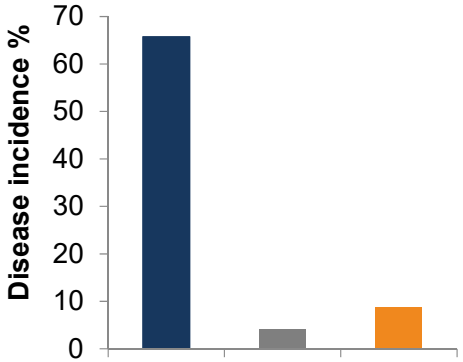
- Evaluation after storage for 27 d at 0 °C

	application rate	active substance
CH1	1 kg/ha	Fenhexamid
CH2	A: 0,75 kg/ha B, C: 1,25 kg/ha	Cyprodinil+ Fludioxonil
CH3	0,84 kg/ha	Boscalid
BOT	0,87 kg/ha	*A. pullulans*

Botector® - Italy, Efficacy and shelf live evaluation in table grapes

Assessment on Nov 20th

Italy, Bari, 2013, Red Globe, University of Bari

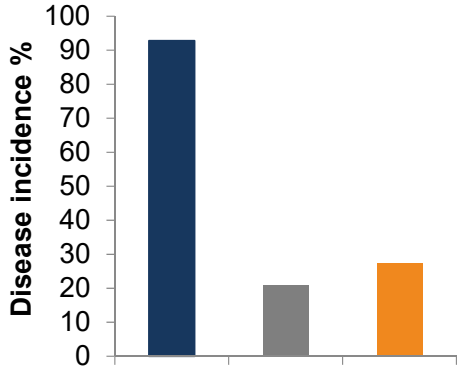


Efficacy	-	94	87	
Significance	a	b	b	4x CH before
17.10.2013	-	CH	BOT	
25.10.2013	-	-	BOT	
31.10.2013	-	CH	BOT	
08.11.2013	-	-	BOT	
14.11.2013	-	CH	BOT	

	active substance
CH	Fluopyram
BOT	*A. pullulans*

Assessment on Dec 27th after 30 days of cold storage
+ 4 days of shelf life

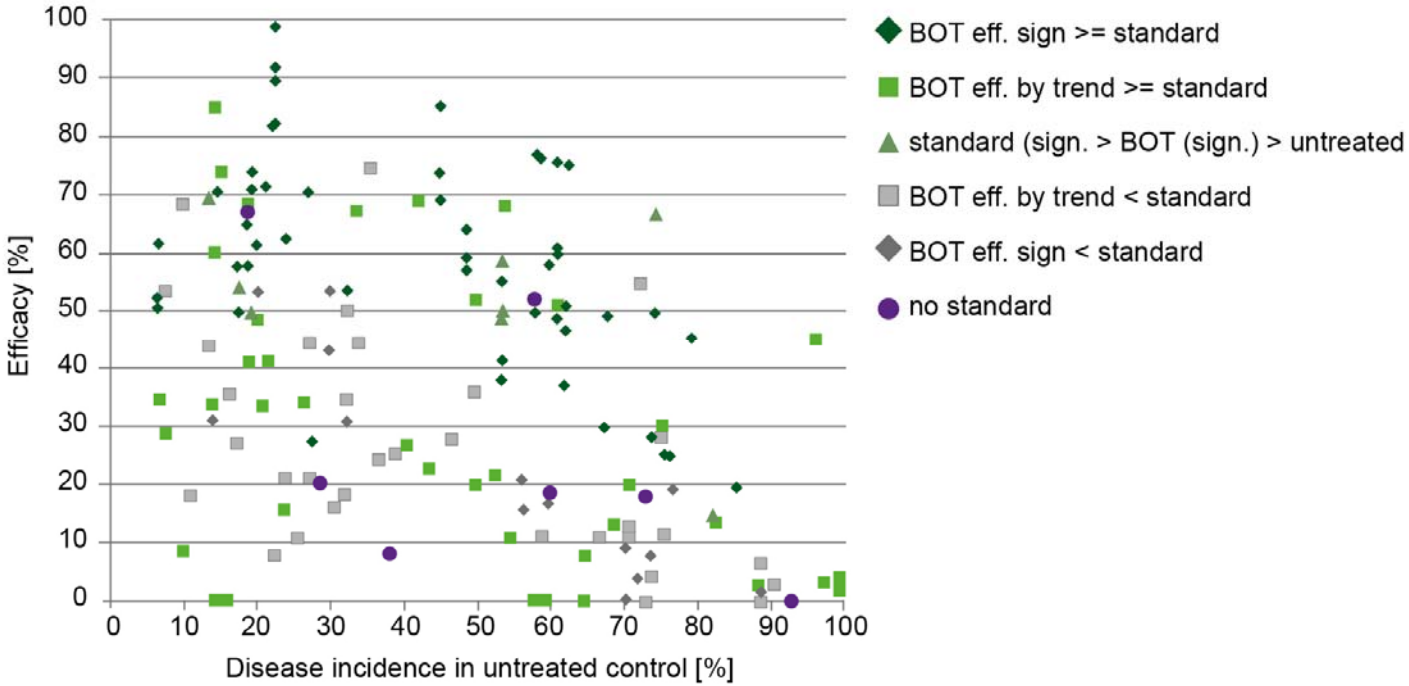
Italy, Bari, 2013, Red Globe, University of Bari



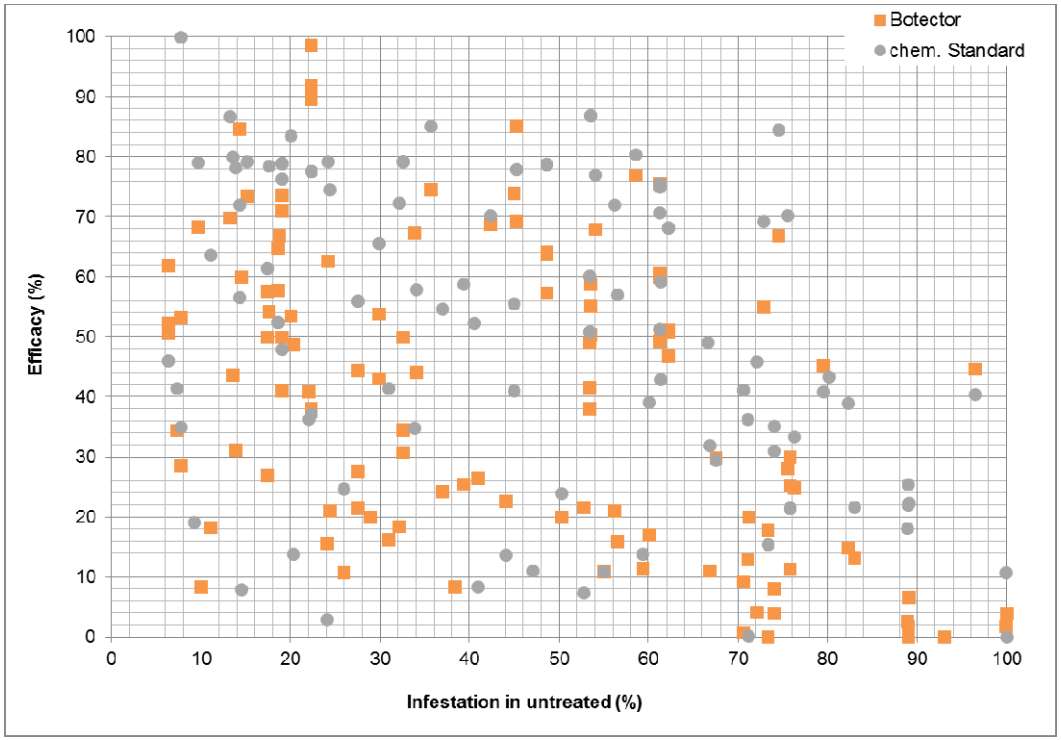
Efficacy	-	77	71	
Significance	a	b	b	4x CH before
17.10.2013	-	CH	BOT	
25.10.2013	-	-	BOT	
31.10.2013	-	CH	BOT	
08.11.2013	-	-	BOT	
14.11.2013	-	CH	BOT	

Botector® - Grapes

Efficacy of Botector® compared to chemical standard botryticides at increasing infection incidence in grape, 110 trials



Botector® and chemical reference product against grey mold in grapes



Botector® - against *Botrytis cinerea* in strawberries

Dose	Kg/ha ground area
Botector	1

- max. 6 preventive applications per season between BBCH stages 61 and 89
- Use the same equipment and volume as for e.g. conventional fungicides

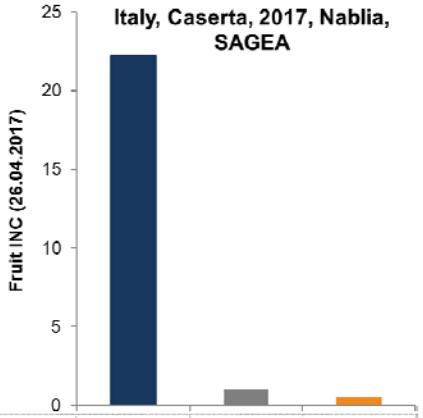
- Note: Most fruit rots start with infections during bloom.
  The pathogen grows into the flower and will colonize the end of the fruit stem.
  Protection of blossoms is critical in a proper gray mold management.
- Please keep a spraying interval of min. ± 3 days to incompatible products
- Clean tank before use
- Use spray suspension within 8h

Strategies:

- Replacement of chemical fungicides
- In addition to chemical fungicides

Botector® - for the Control of Botrytis in strawberry

GEP trial conducted by Sagea, Italy



Efficacy		-	95	98
Significance		a	b	b
BBCH 55	22.03.2017	-	CH1	BOT
BBCH 61	29.03.2017	-	CH2	BOT
BBCH 65	05.04.2017	-	CH1	BOT
BBCH 67	12.04.2017	-	CH2	BOT
BBCH 73	19.04.2017	-	CH1	BOT
BBCH 85	26.04.2017	-	CH2	BOT

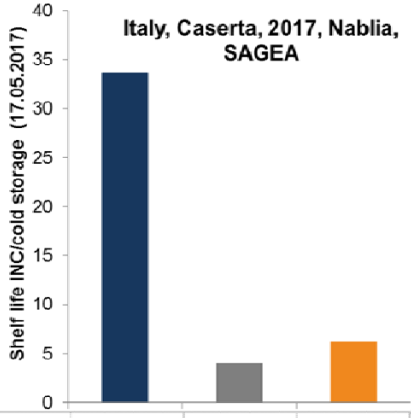
	application rate	active substance
CH1	0.8 kg/ha	Cyprodinil/ Fludioxonil
CH2	1.5 kg/ha	Fenhexamid
BOT	1 kg/ha	*A. pullulans*

other commer *Botrytis cinerea*

- 6 applications made weekly
- 2 harvests were made, all showed the same trend, a significant reduction of fruit incidence
- Infection pressure was medium
- Grown under protected conditions

Botector® - for the Control of Botrytis in strawberry

GEP trial conducted by Sagea, Italy



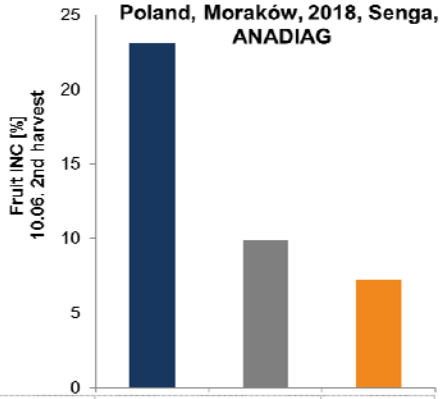
Efficacy		-	88	82
Significance		a	b	b
BBCH 55	22.03.2017	-	CH1	BOT
BBCH 61	29.03.2017	-	CH2	BOT
BBCH 65	05.04.2017	-	CH1	BOT
BBCH 67	12.04.2017	-	CH2	BOT
BBCH 73	19.04.2017	-	CH1	BOT
BBCH 85	26.04.2017	-	CH2	BOT

	application rate	active substance
CH1	0.8 kg/ha	Cyprodinil/ Fludioxonil
CH2	1.5 kg/ha	Fenhexamid
BOT	1 kg/ha	*A. pullulans*
other commer		*Botrytis cinerea*

- Shelf-life evaluation in cold storage
- Nabalia= remontant variety
- Fruits for storage picked on 13.05.2017
- Fruits for 4 days in storage

Botector® - for the Control of Botrytis in strawberry

GEP trial conducted by Anadiag, Poland



Efficacy		-	57	69
Significance		a	b	b
BBCH 55	04.05.2018	-	CH1	BOT
BBCH 61	11.05.2018	-	CH2	BOT
BBCH 65	18.05.2018	-	CH3	BOT
BBCH 71	25.05.2018	-	CH2	BOT
BBCH 85	01.06.2018	-	CH3	BOT
BBCH 89	08.06.2018	-	CH3	BOT

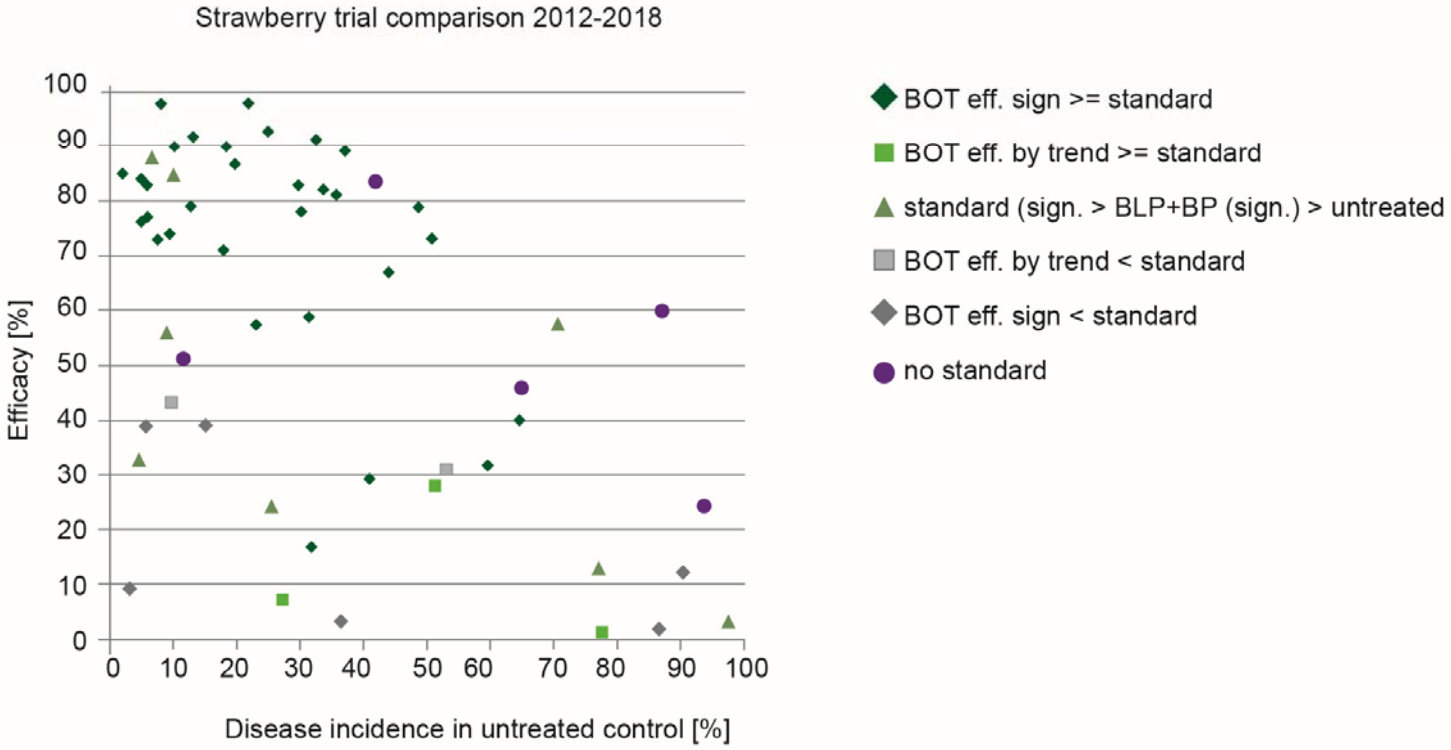
- 6 applications made weekly
- 3 harvests were made, all showed the same trend, a significant reduction of fruit incidence
- Infection pressure was medium
- Grown in polyethylene tunnel on raised soil beds with black plastic mulch coverage

	application rate	active substance
CH1	1,8 kg/ha	67 g/kg (6,7 Gew.%) Pyraclostrobin 267 g/kg 26,7 Gew.%) Boscalid
CH2	0,8 kg/ha	375 g/kg (37,5 Gew.%) Cyprodinil 250 g/kg (25 Gew.%) Fludioxonil
CH3	1,5 l/ha	Fenhexamid 500 g/L
BOT	1 kg/ha	*A. pullulans*

other comments: Botrytis cinerea

Botector®

Control of Botrytis in strawberry (N=32 trials)



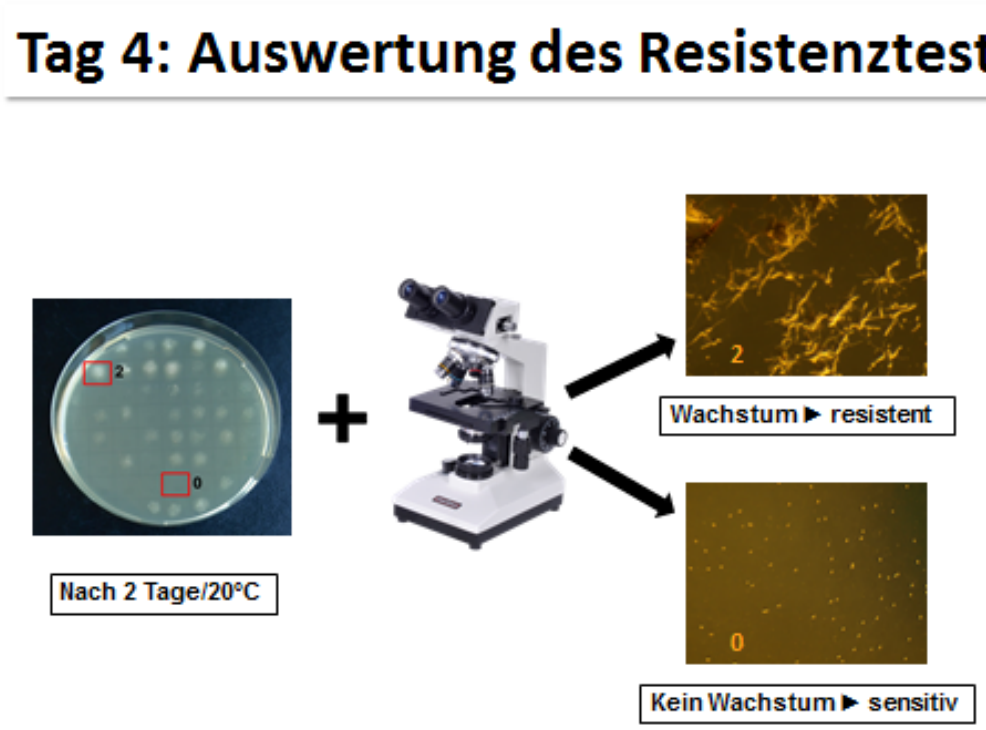
Resistenztest *Botrytis*

Probennahme:

Eine Feldprobe besteht aus 20 Einzelproben die über das Feld verteilt gesammelt wurden - am effektivsten entlang der Feldlongitudinale.

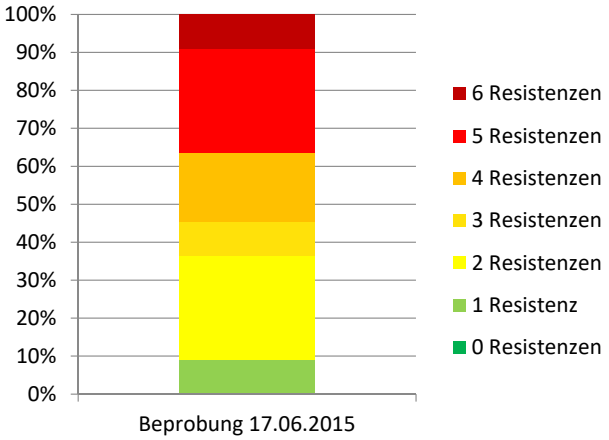
Resistenztest *Botrytis*

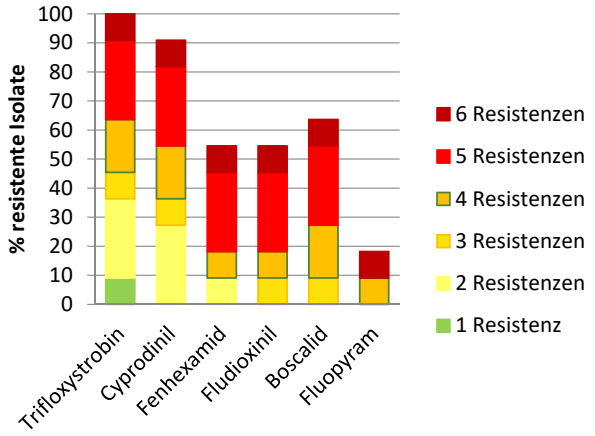
Von jeder Beere wird ein Isolat gewonnen und die Konidien untersucht



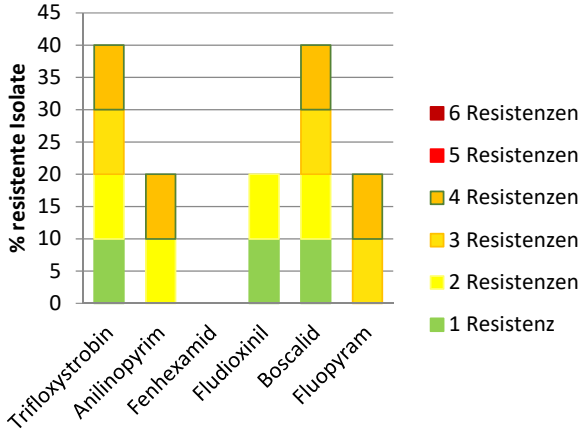
Entwicklung Resistenztest *Botrytis*

FL, 2015





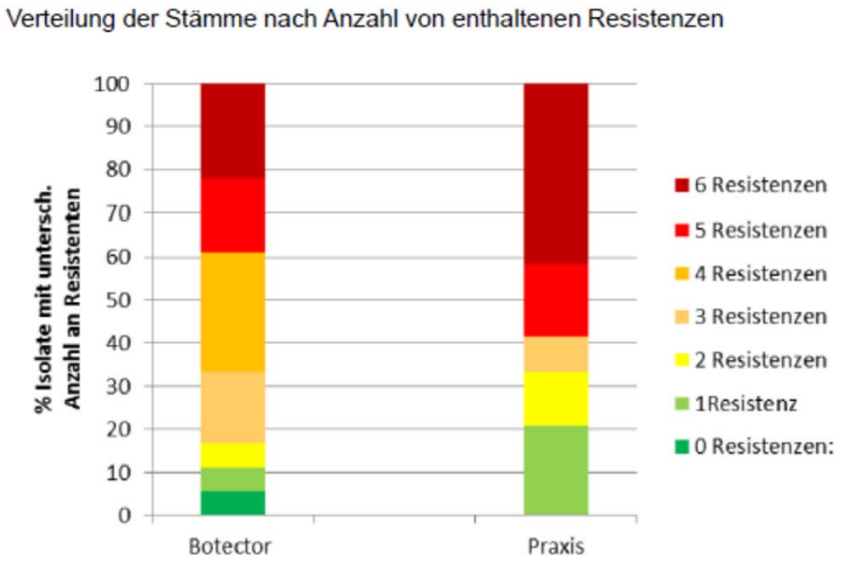
OC, Clery, 2016



Bio-Protect

www.bio-protect.de

Resistenzstatus der Botrytispopulation nach Anwendung von Botector oder der Praxisvariante



Classification according to the Fungicide Resistance Action Committee (FRAC): FRAC Code: NC-> resistance management!

CONCLUSIONS:

30 years after investigation, 10 years after submission in EU

-> timelines in registration, especially EU

-> market potential:

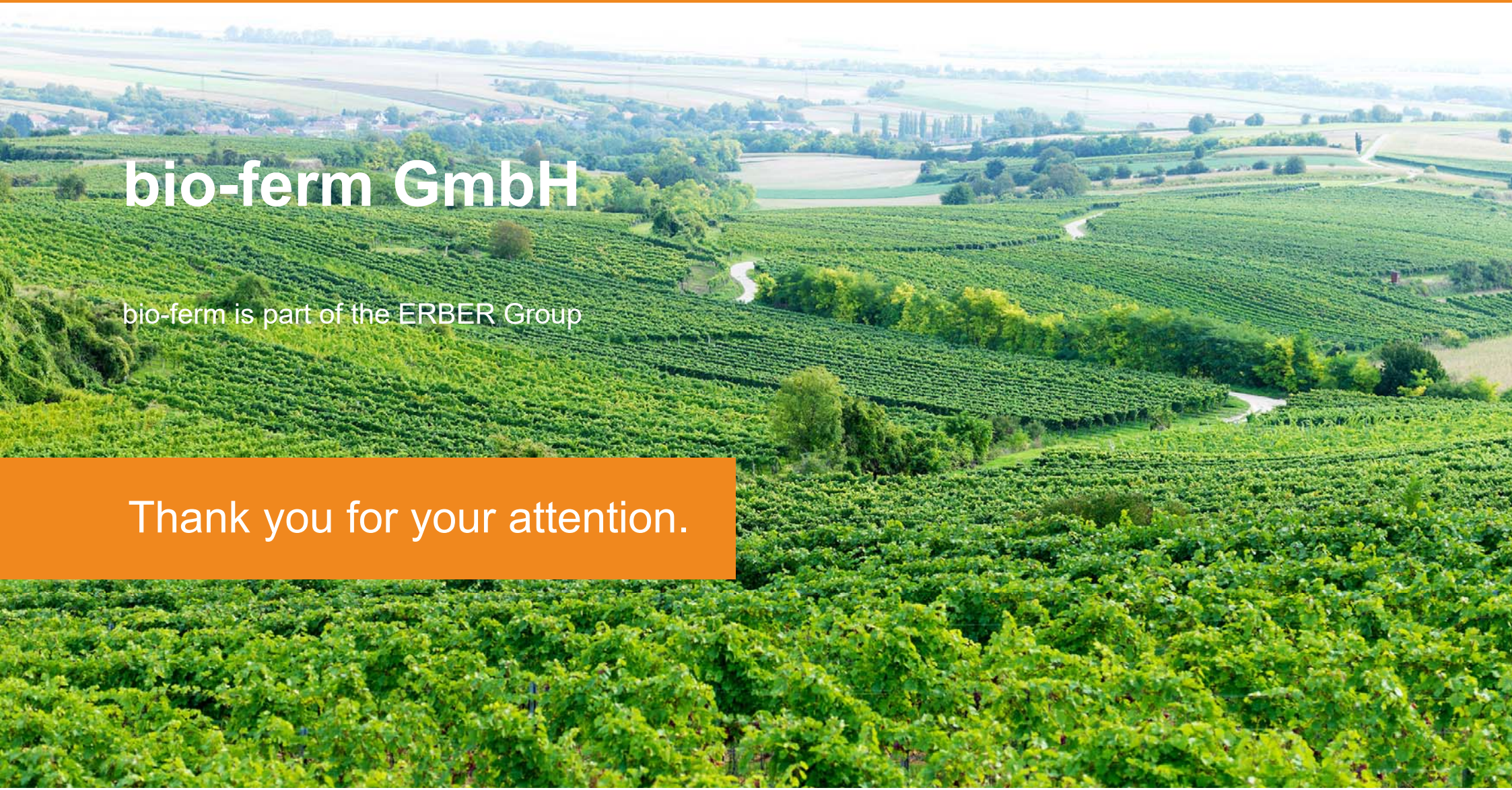
Most important: trust of advisers and farmers in new techniques, that the efficacy of a biological product can be equivalent to chemical pesticides.

Label claims:

40%-60% Efficacy = Some control

60%-80% Efficacy = partial (moderate) control, supression

80%-100% Efficacy = full control



bio-ferm GmbH

bio-ferm is part of the ERBER Group

Thank you for your attention.