



Fungicider – i dag och framtidsutsikter

2017

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Dagsorden – focus on septoria resistance

- Problems with resistance
- Results with New SDHI chemistry
- Results with azoles
- Problems with resistance
- New chemistry
 - Revysol
 - INATREQ



Problems with resistance

Fungicide groups available – effect profile (*) and resistance risk

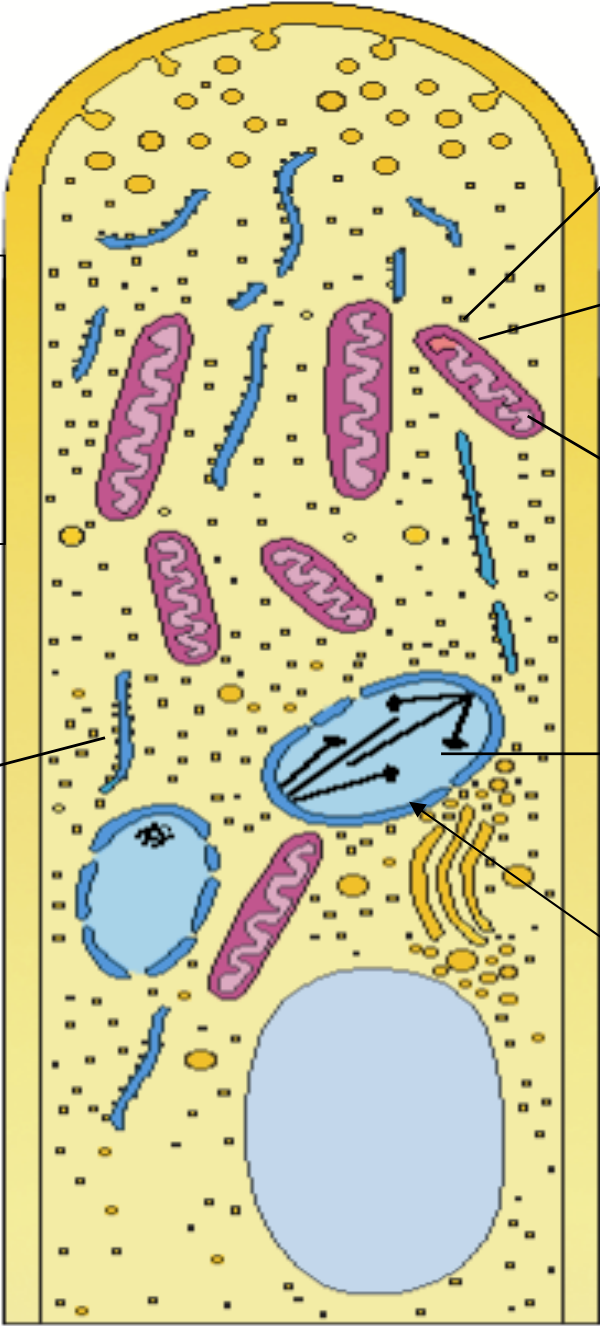
Crop	Diseases	Strobilurins	Triazoles	SDHI	Mildewicides	Folpan Chlorothalonil
Wheat	Septoria tritici blotch	High risk	Moderate risk (*)	Moderate risk ****	Low risk	Low risk **
	Stripe rust	Low risk ****	Low risk ****	Low risk **	Low risk	Low risk *
	Brown rust	Low risk ****	Low risk ****	Low risk **	Low risk	Low risk *
	Tan spot	Moderate risk **	Moderate risk (*)	Low risk *	Low risk	Low risk *
	Powdery mildew	High risk	Moderate risk ***	Low risk *	Moderate risk ***	Low risk *
Barley	Brown rust	Low risk ****	Low risk ****	Low risk **	Low risk	Low risk *
	Net blotch	Moderate risk ***	Moderate risk (*)	Moderate risk ****	Low risk	Low risk *
	Rhynchosporium	Low risk ****	Low risk ****	Low risk ****	Low risk	Low risk *
	Ramularia	High risk	Moderate risk (*)	Moderate risk ****	Low risk	Low risk (*)
	Powdery mildew	Moderate risk **	Moderate risk ***	Low risk *	Low risk ****	Low risk *

High risk Moderate risk Low risk

Fungi cell

Dithiocarbamates
*Protein creation ,
respiration*

Azoles/DMI
*endoplasmatic
reticulum*



Inatreq
mitochondrial

SDHI
mitochondrial

Strobilurins
mitochondrial

Benzimidazols
Cell nucleor

Phenylamides
Cell nucleo

Fungicides available for control of wheat diseases - Sweden



mildew	Rust	Septoria	DTR	Fusarium	Eyespot
Fenpropidin Fenpropi- morph Metrafenon Proquinazid	Prothio- conazole Propiconazol	Prothioconazole Difenoconazol Propiconazole	Prothio- conazole Propiconazole	Prothio- conazole	Prothiocona- zole
Prothioconazole	Pyraclostrobin Picoxystrobin Azoxystrobin	Bixafen, Fluxapyraxad Fluopyram Solatenol	(Pyraclostrobin)		Metrafenon
		Folpet			cyprodinil

Red ones might go out !!!

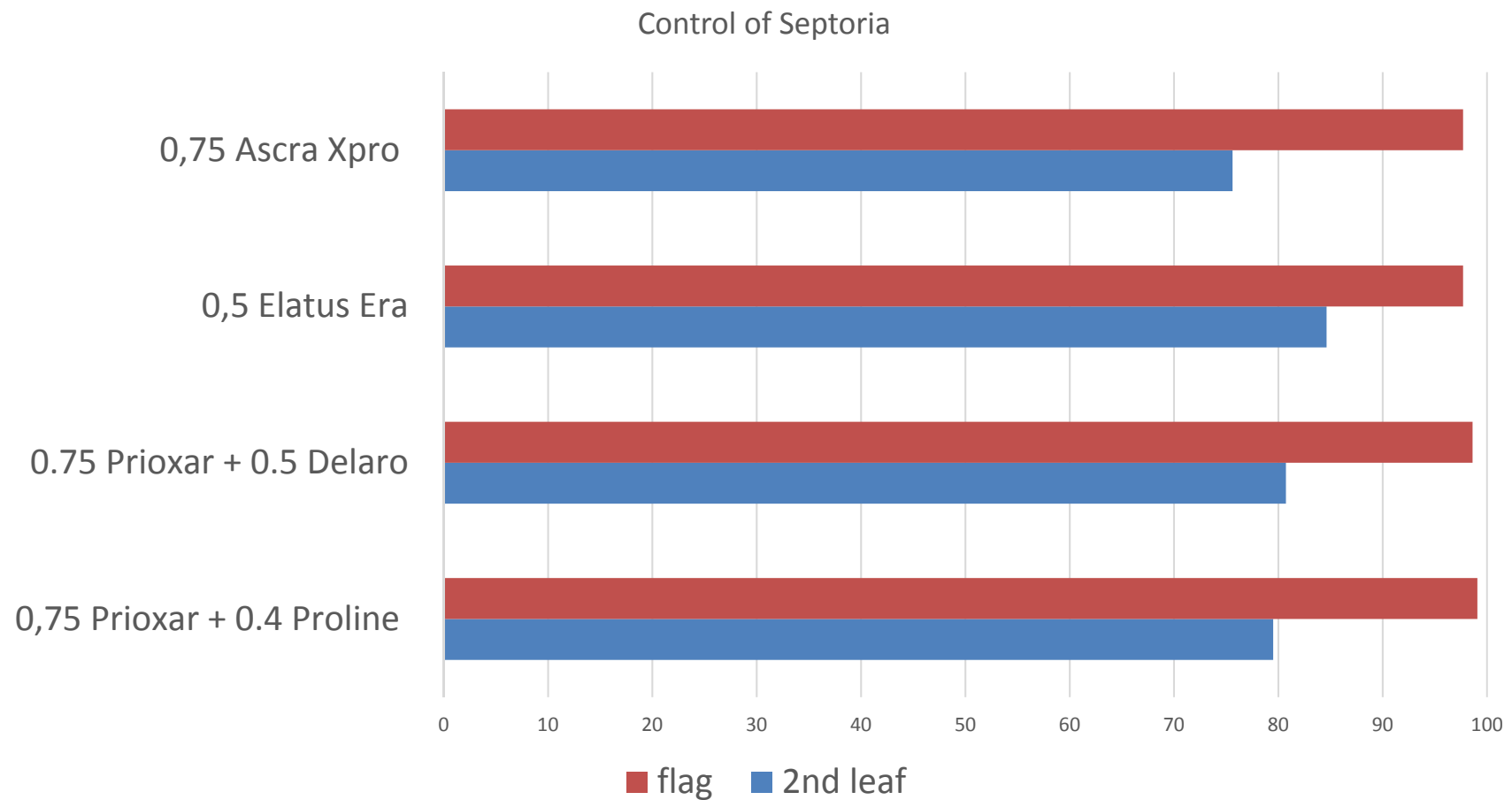
SDHI- fungicides

- **1.08 Ascra Xpro:** 65 bixafen + 65 fluapyram + 130 prothioconazole
- **1.0 Aviator Xpro** – 75 bixafen + 150 prothioconazole
- **0.75 Siltra xpro** – 60 Bixafen + 150 prothioconazole
- **1.0 Propulse:** 125 fluopyram + 125 prothioconazole

- **1.0 Elatus Era :** 75 Solatenol + 150 prothioconazole
- **0,75 Elatus plus :** 100 g Solatenol

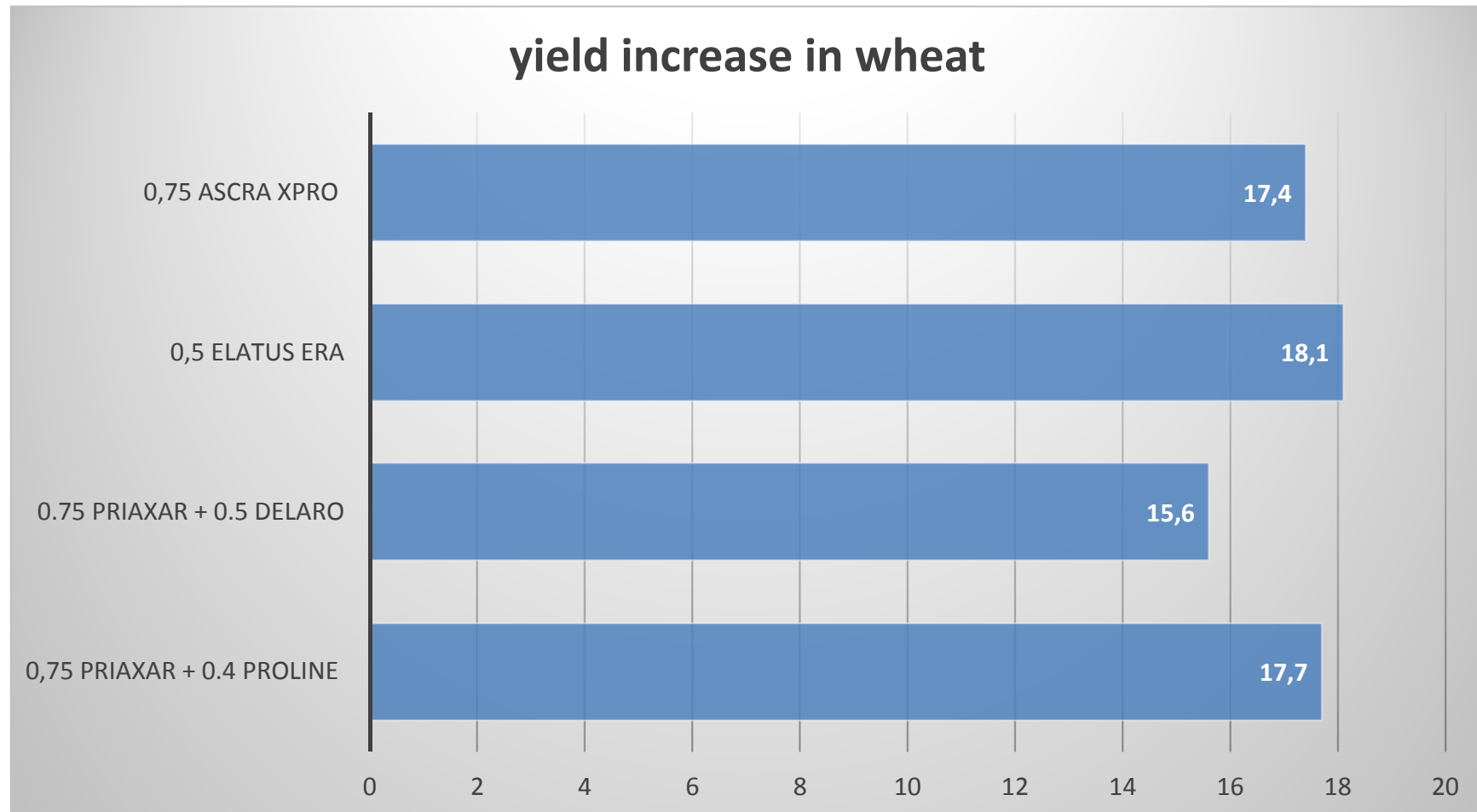
- **1.5 Priaxor** – 75 g fluxapyrozad + 150 g pyraclostrobin

%Control of septoria –1 trial 2017



New SDHI solutions are very effective solutions!

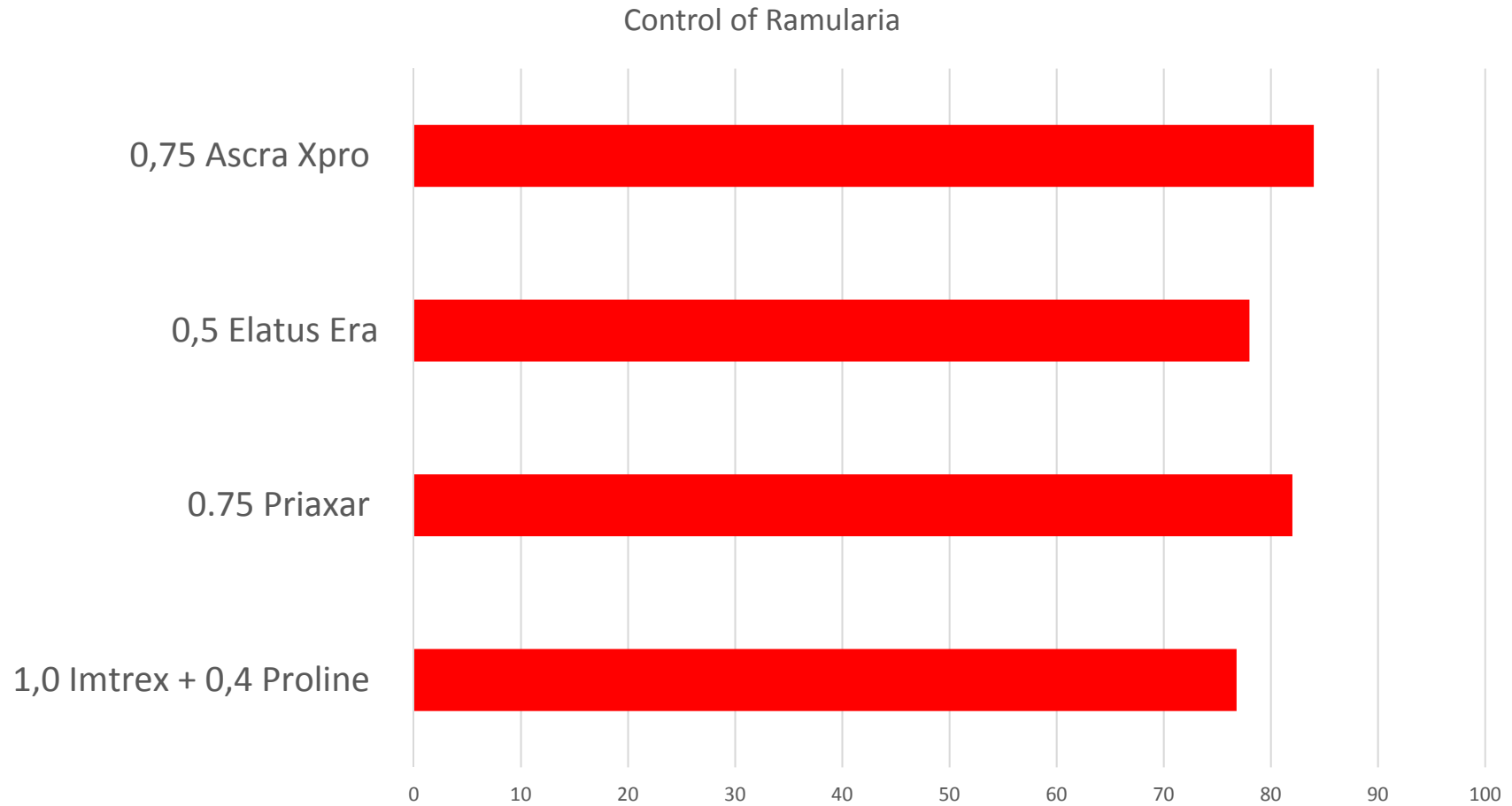
Yield responses (hkg/ha) in wheat – treatments at GS 39 -1 trial 2017



LSD = 3,9

%control of Ramularia in spring barley

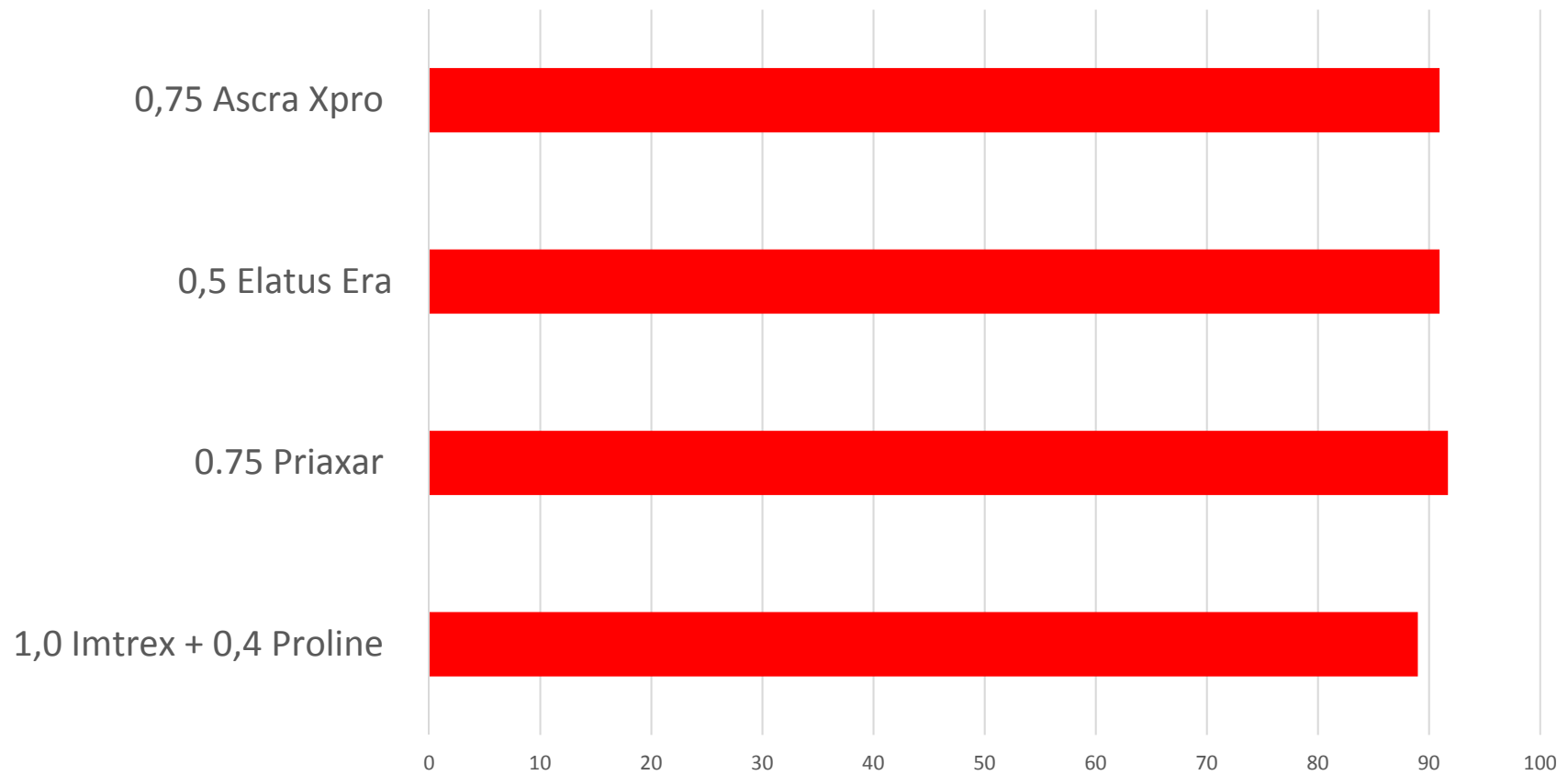
25% attack in untreated



%Control of brown rust in spring barley

66% attack in untreated

Control of brown rust in barley



Spring barley

Control of rust and ramularia

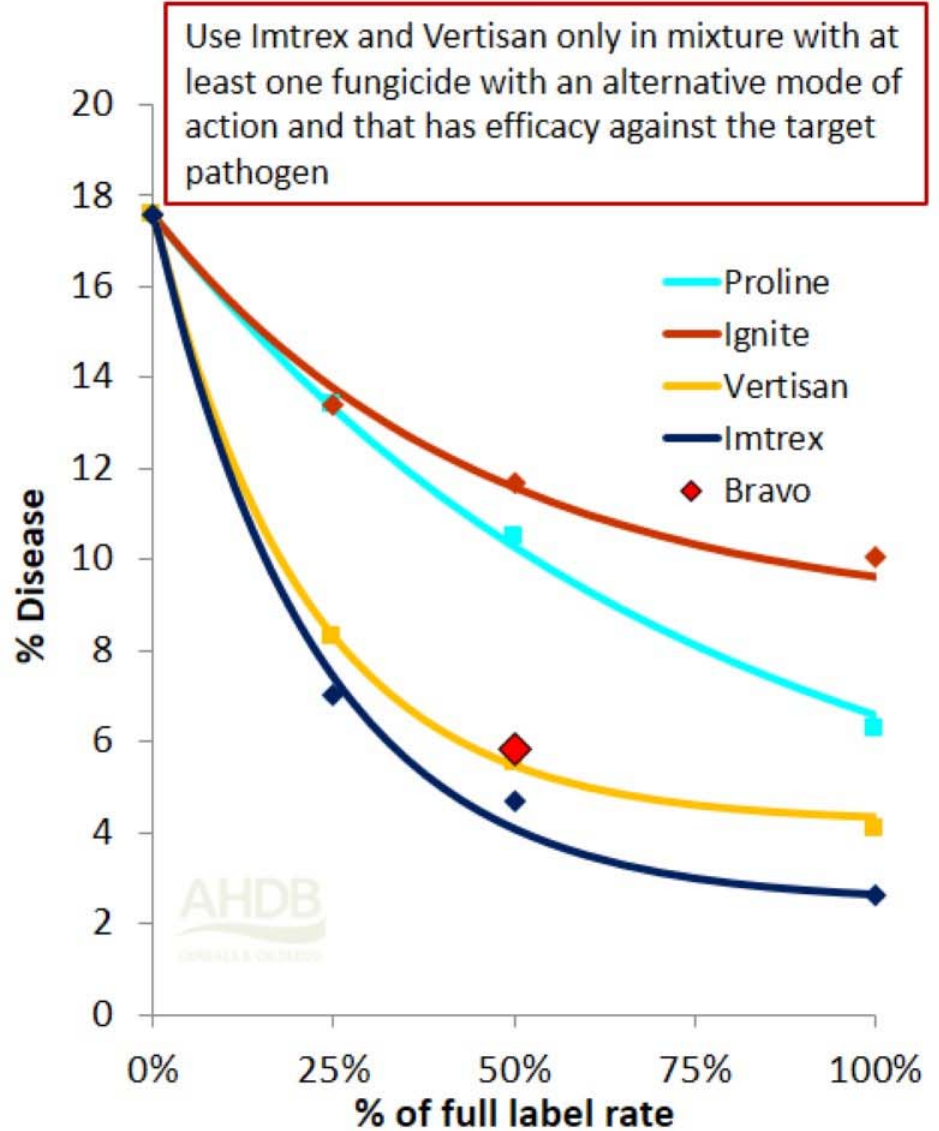
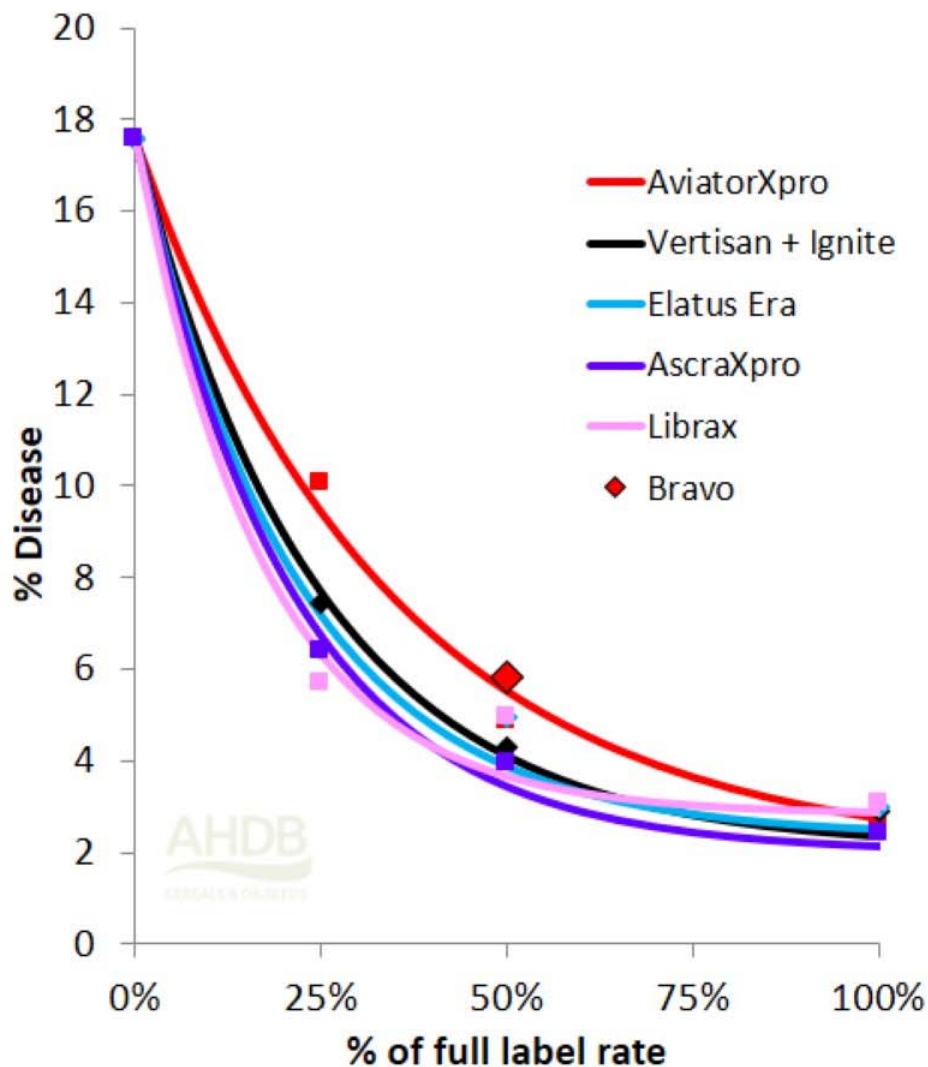
Untreated



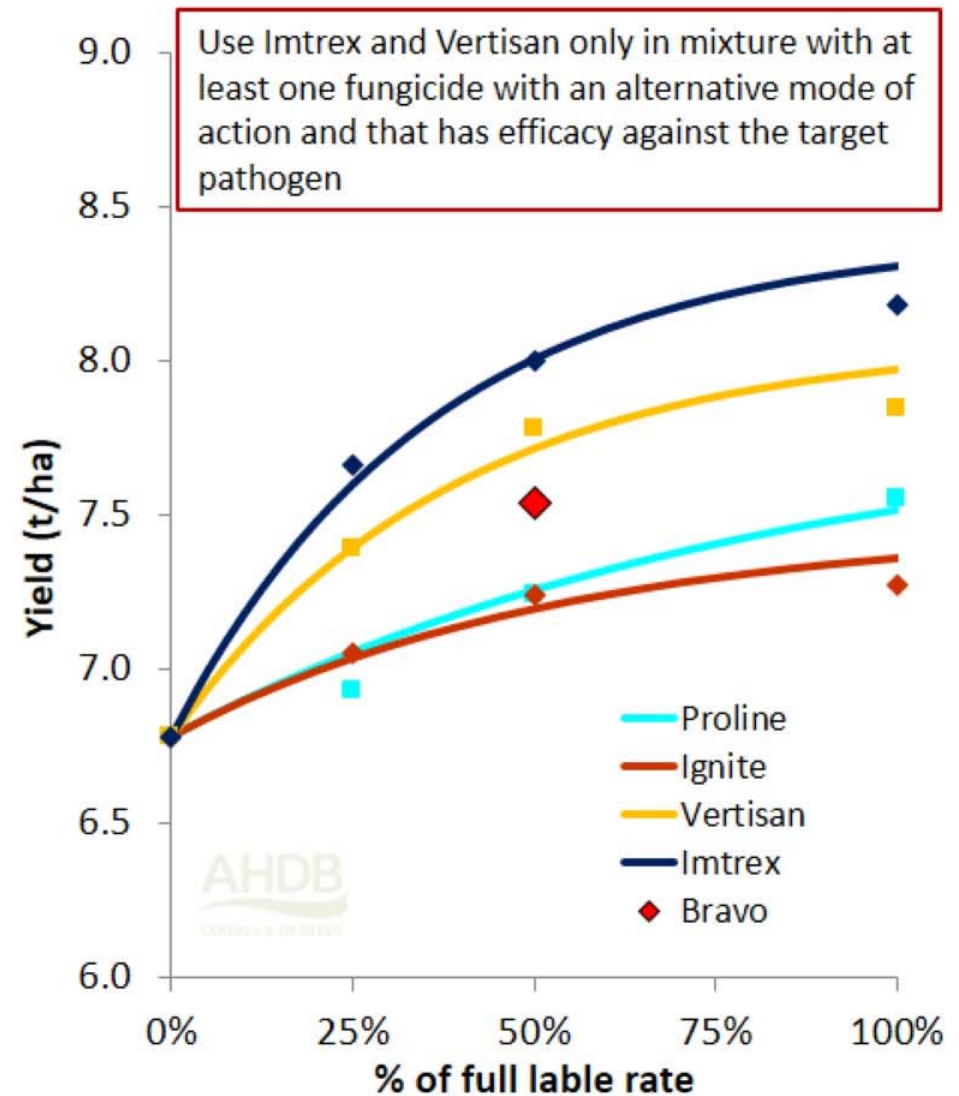
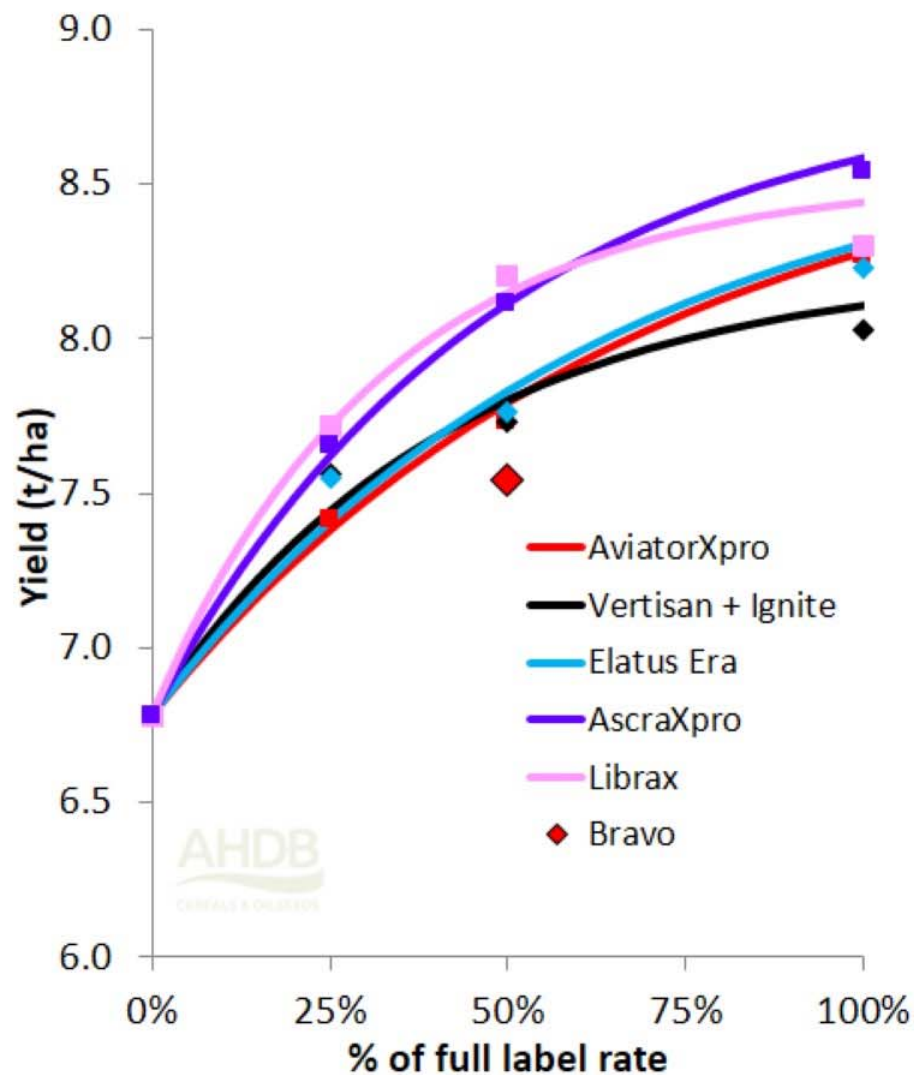
0.5 Elatus Era



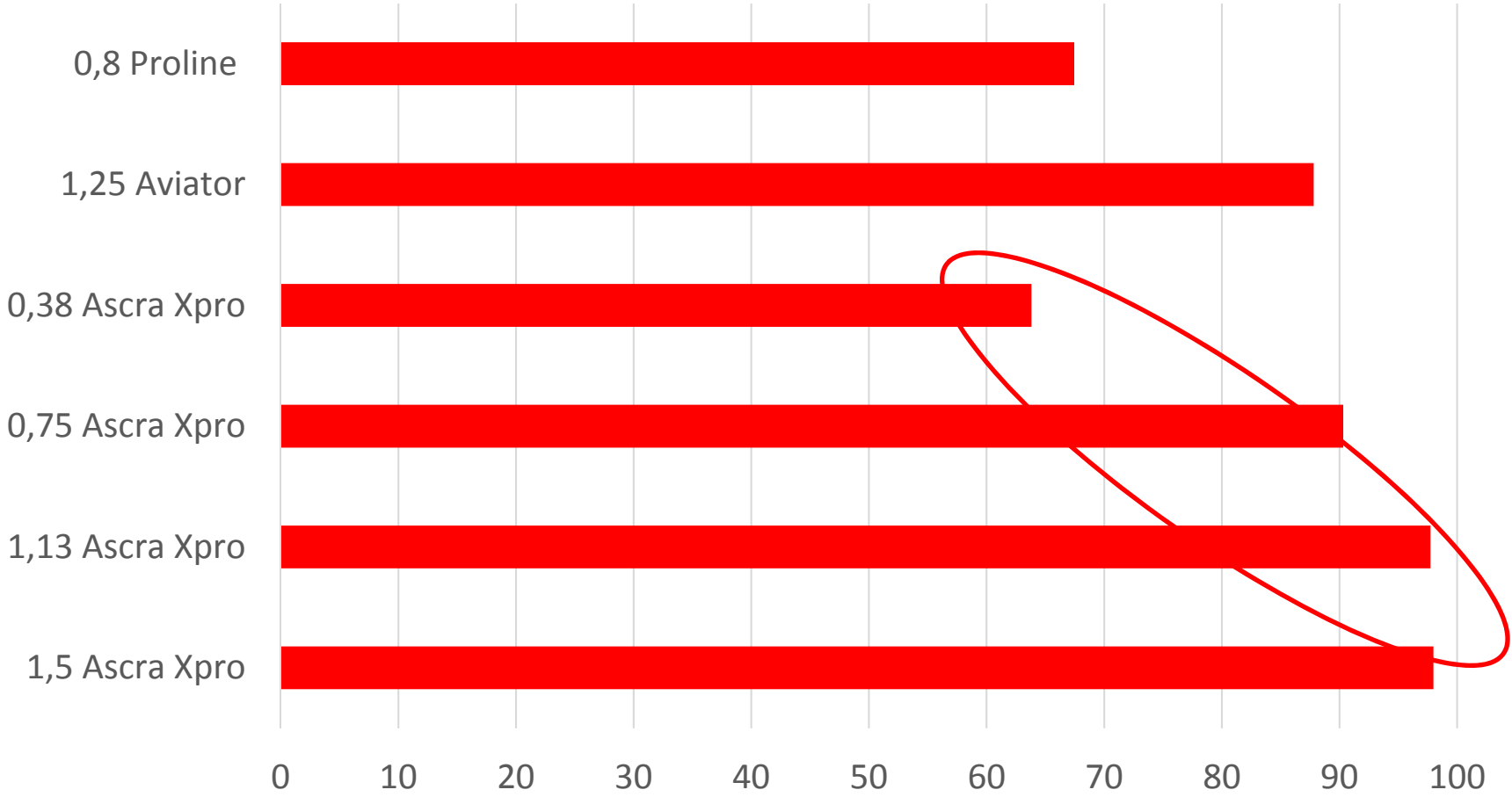
Septoria protectant 2016 (7 trials)



Septoria yield 2016 (7 trials)

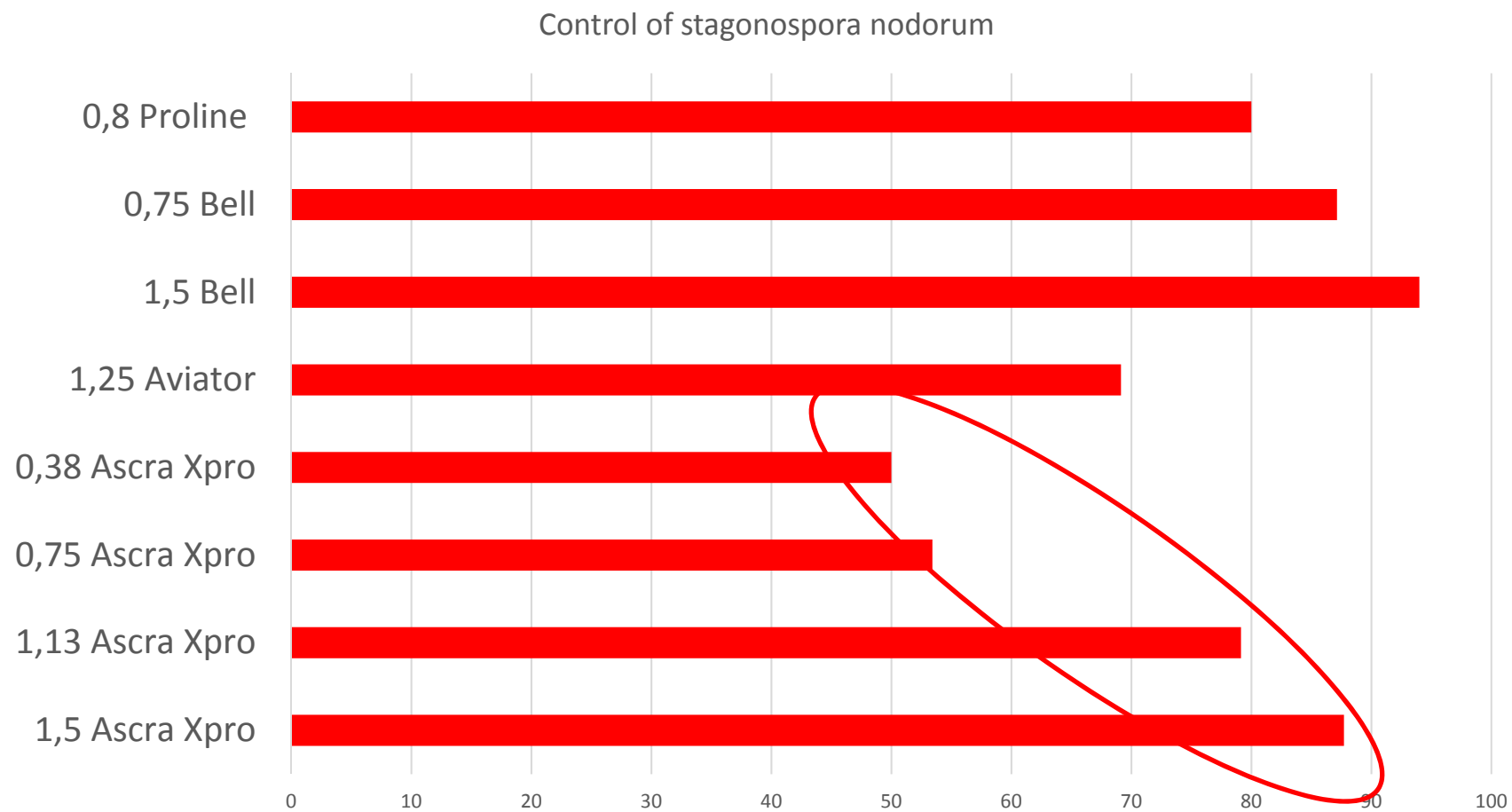


%Control of septoria in wheat – 3 trials 2013

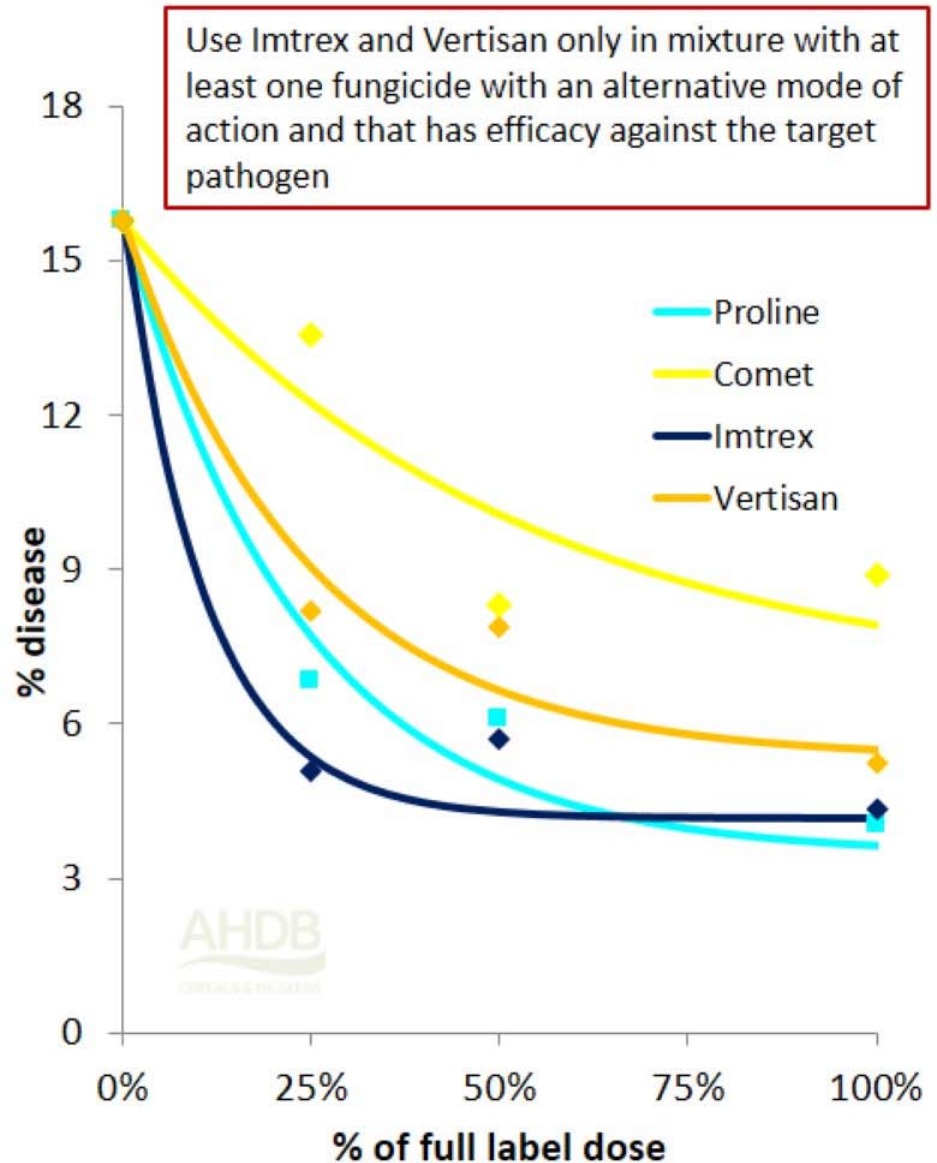
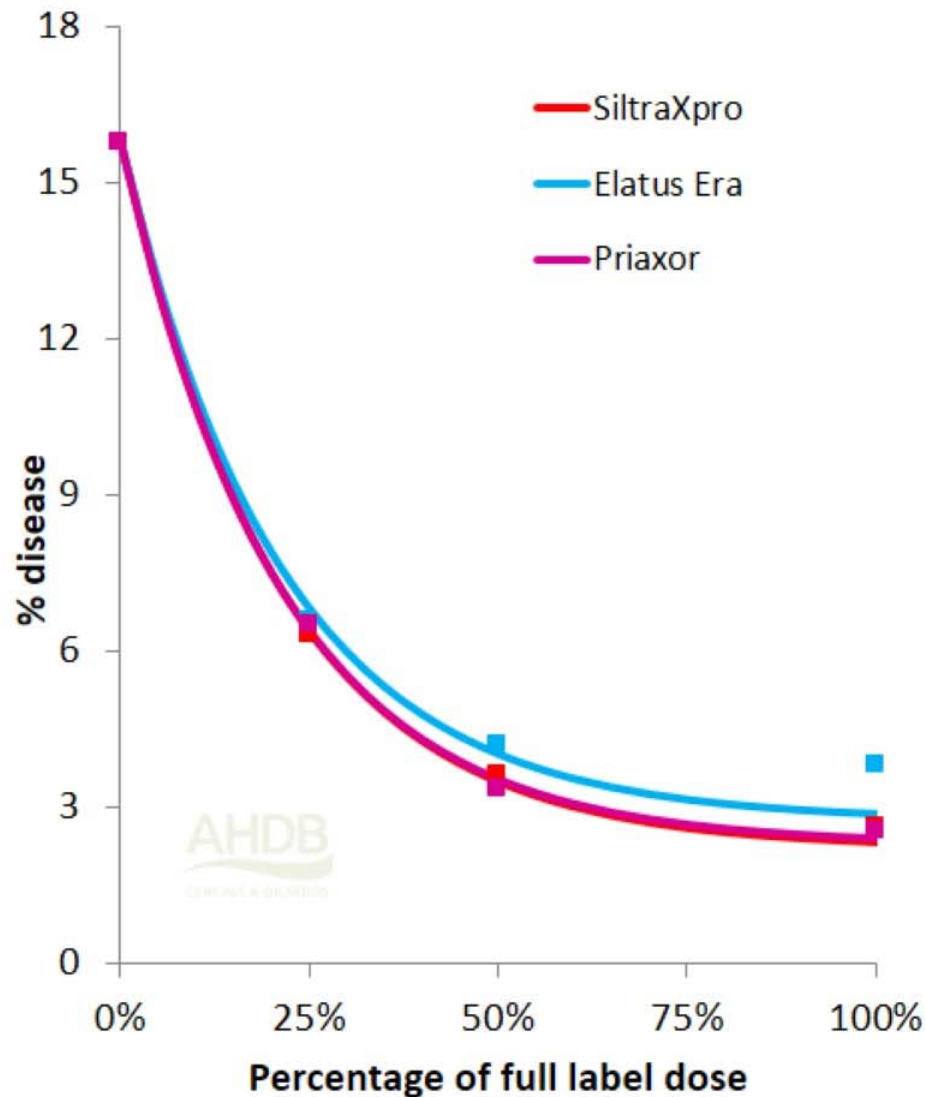


80% attack in untreated at gs 75

%Control of *Stagonospora nodorum* in triticale – 1 trial



Rhynchosporium protectant 2016 (4 trials)



Summary on new SDHI-fungicides

Strong cereal fungicides

Wheat : good effect on septoria, brown rust, DTR and yellow rust – moderate effect on mildew

Barley: good effect on Rhyncho, net blotch, brown rust and Ramularia

Triticale and Rye: Good effect on brown rust and Rhyncho, moderate effect on Stagonospora

Oat: Good effect on mildew and leaf spot

Oh my Good – experinces from Irland!

- Oak park Teagacs
- Euro-res meeting in Ireland



Ireland – Reduced efficacy of SDHIs

2 x 0.8 Elatus Era



2 x 0.8 Elatus Era + 1.0 Bravo



SDHI's do not provide good control anymore – *Z. triticii* has 75% C-T79N mutations - causing reduction in field performances. Combined with azoles and chlorothalonil in a 3 spray strategy They still obtain good control.

Ireland - Euro-res

3 treatments

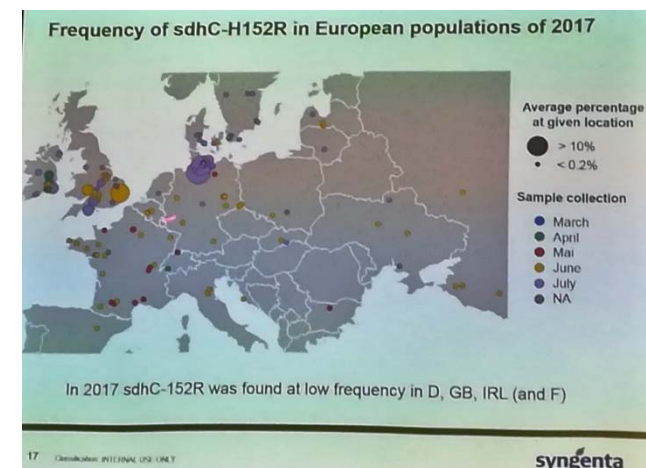
1.2 Ascra xpro + 1.0 Bravo, 1.6 Librax + 1.0 Bravo, 1.0
Prosaro

Proline 2 x 0.8



Resistance situation SDHI

- Resistance to SDHI in septoria - affected by mutations and efflux, not overexpression
- Known mutations of importance:
 - T79N, N86K, G90R, H152R
- None of these in Scandinavia so far - 2016
- Still waiting for 2017 result?



Recommendationer i en godisbutik!!

- Do not overuse the SDHI's
 - Use them only once per season !!!
 - GS39 is the best timing !
 - Very similar solutions among the new solutions
-
- Do still remember to use IPM elementer - like resistance cultivars, monitoring, riskmodels, etc



Historien om DMI/Azoler

A sad story



A happy story

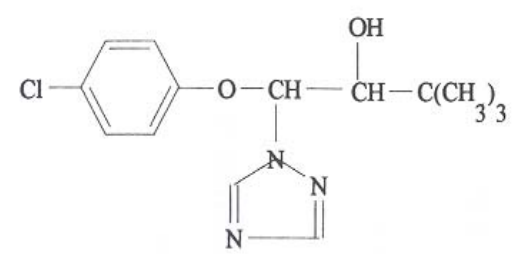


Table 3.6. The triazole family of fungicides

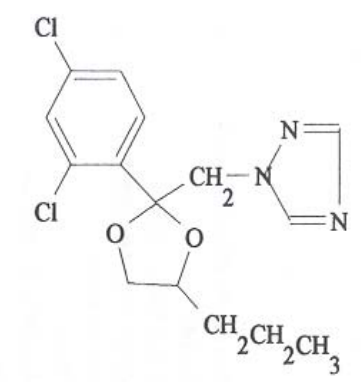
Compound	Date annour
Triadimefon	1973
Triadimenol	1978
Propiconazole	1979
Bitertanol	1979
Diclobutrazol	1979
Flutriafol	1981
Penconazole	1983
Azaconazole	1983
Diniconazole	1983
Flusilazole	1984
Imibenconazole	1984
Tebuconazole	1986
Cyproconazole	1986
Myclobutanil	1986
Tetraconazole	1988
Difenconazole	1988
Furconazole	1988
Epoxiconazole	1990
Hexaconazole	1990
SSF-109	1990
Bromuconazole	1990
Fluquinconazole	1992
Metconazole	1992

Prothioconazole 2005

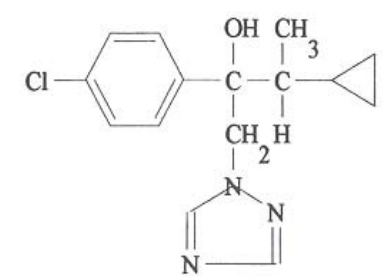
Revysol 2019



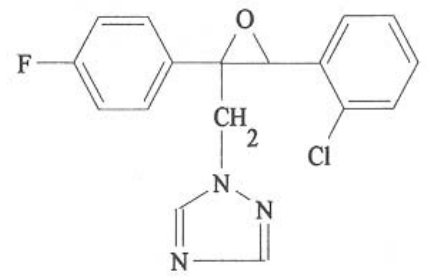
triadimenol



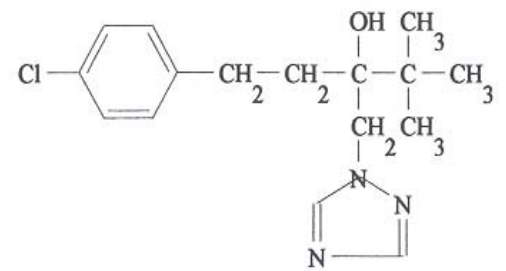
propiconazole



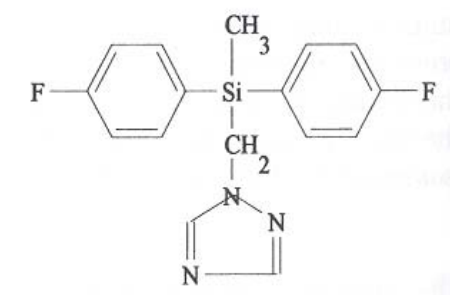
cyproconazole



epoxiconazole



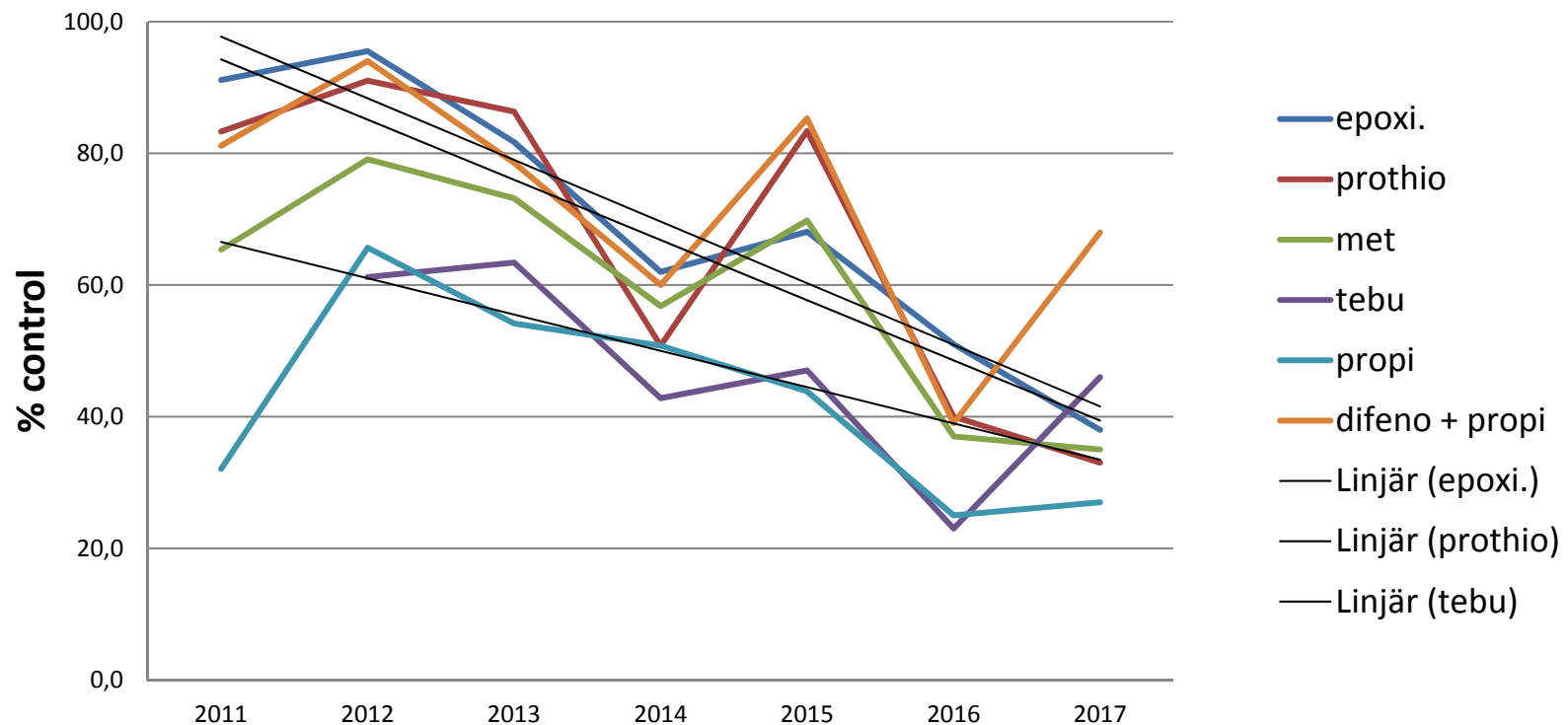
tebuconazole



flusilazole

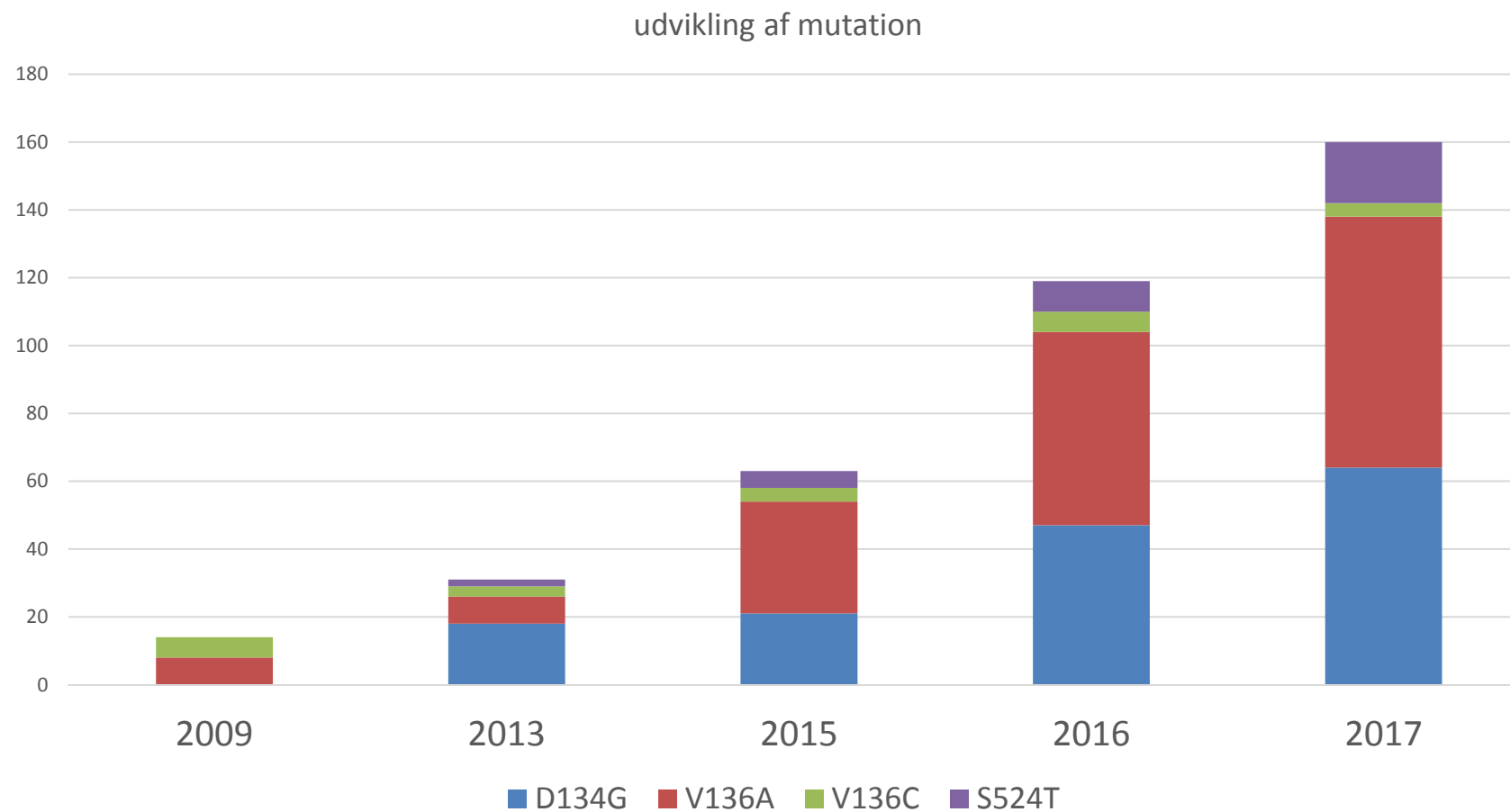
Azole's control of septoria on flag leaf using 2 x 1/2 rate –Danish trials

Control of septoria on flag leaf



Lower efficacy from products leads to use of higher rates and input

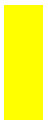
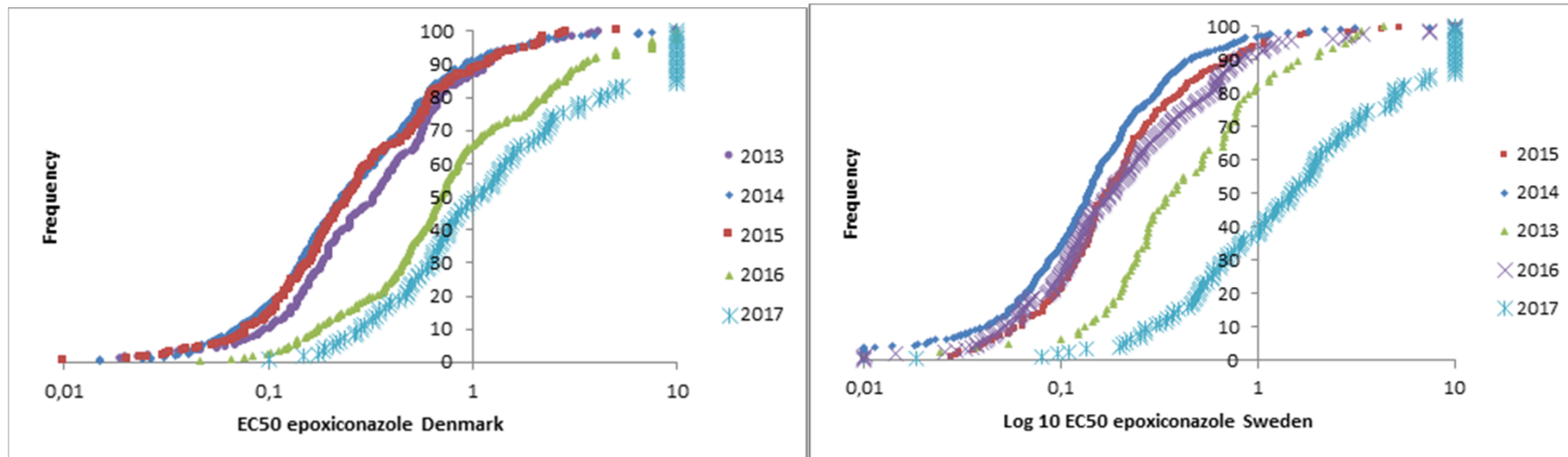
Development of new mutations in septoria populations in Denmark



Sensitivity test of azoles (Epoxi) results from 2017 isolates

Danish – 125 isolater fra 21 lokaliteter

Sweden 170 isolater fra 18 lokaliteter



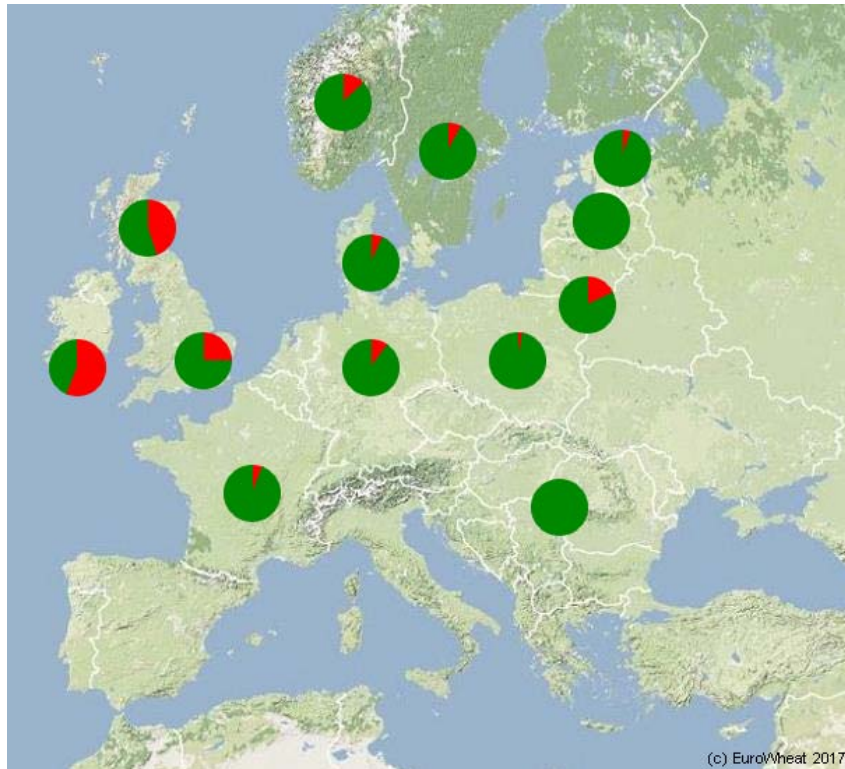
Frekvens af CYP51 mutationer i septoria populationen. Assessed using either Kasp or pyrosequencing samples from 2016 (Thies, phd work)

	CYP51 (%)							QoI (%)	SDHI (%)			
	D134G	V136A	V136C	Y137F	G379A	I381V	S524T		G143A	T79N	N86K	G90R
Danmark syd jylland	60%	68%	5%	0%	89%	100%	9%	98%	0%	0%	0%	0%
Danmark nord ivlland	45%	53%	6%	0%	75%	96%	12%	97%	0%	0%	0%	0%
Danmark øerne	36%	51%	7%	0%	72%	90%	7%	98%	0%	0%	0%	0%
Sverige (Syd)	49%	64%	5%	0%	89%	91%	12%	96%	0%	0%	0%	0%
Sverige (Mellom)	3%	11%	6%	0%	77%	96%	3%	85%	0%	0%	0%	0%
Norge	55%	49%	5%	0%	90%	97%	13%	99%	0%	0%	0%	0%
Litauen	2%	9%	21%	0%	66%	100%	18%	79%	0%	0%	0%	0%
Letland	1%	8%	10%	0%	89%	96%	2%	31%	0%	0%	0%	0%
Estland	0%	15%	3%	0%	79%	99%	5%	43%	0%	0%	0%	0%
Slesvig-Holsten	51%	61%	7%	0%	89%	100%	19%	89%	0%	0%	0%	0%

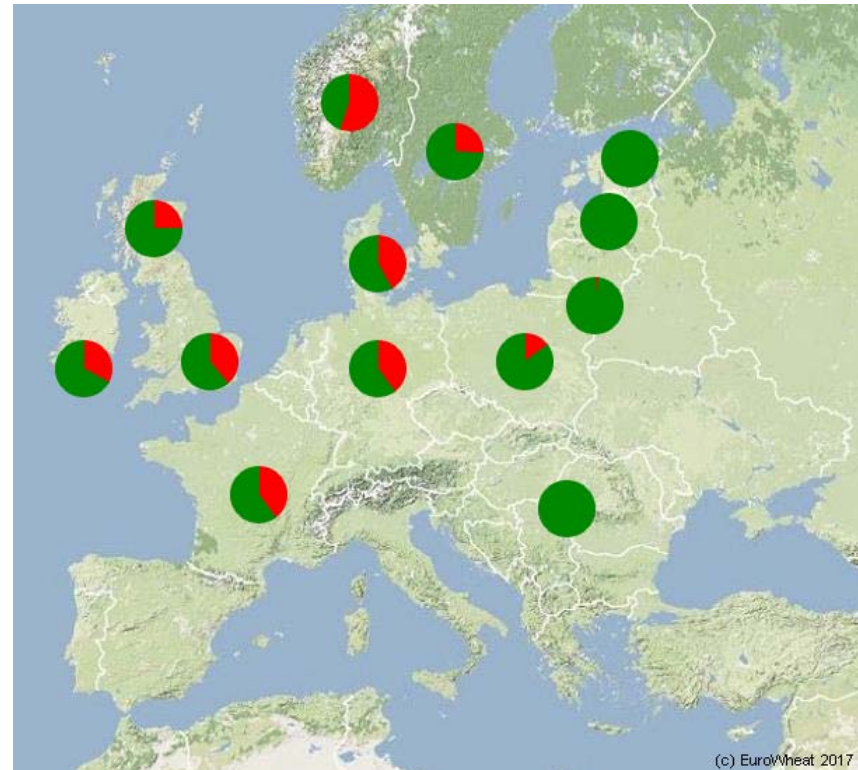
EuroWheat data from 2016

CYP51-mutations in *Zymoseptoria tritici*

S524T



D134G



Kilde : Jørgensen et al 2017, Eurowheat

17329-1 Cleveland 1.july

2 x 0.4 Proline

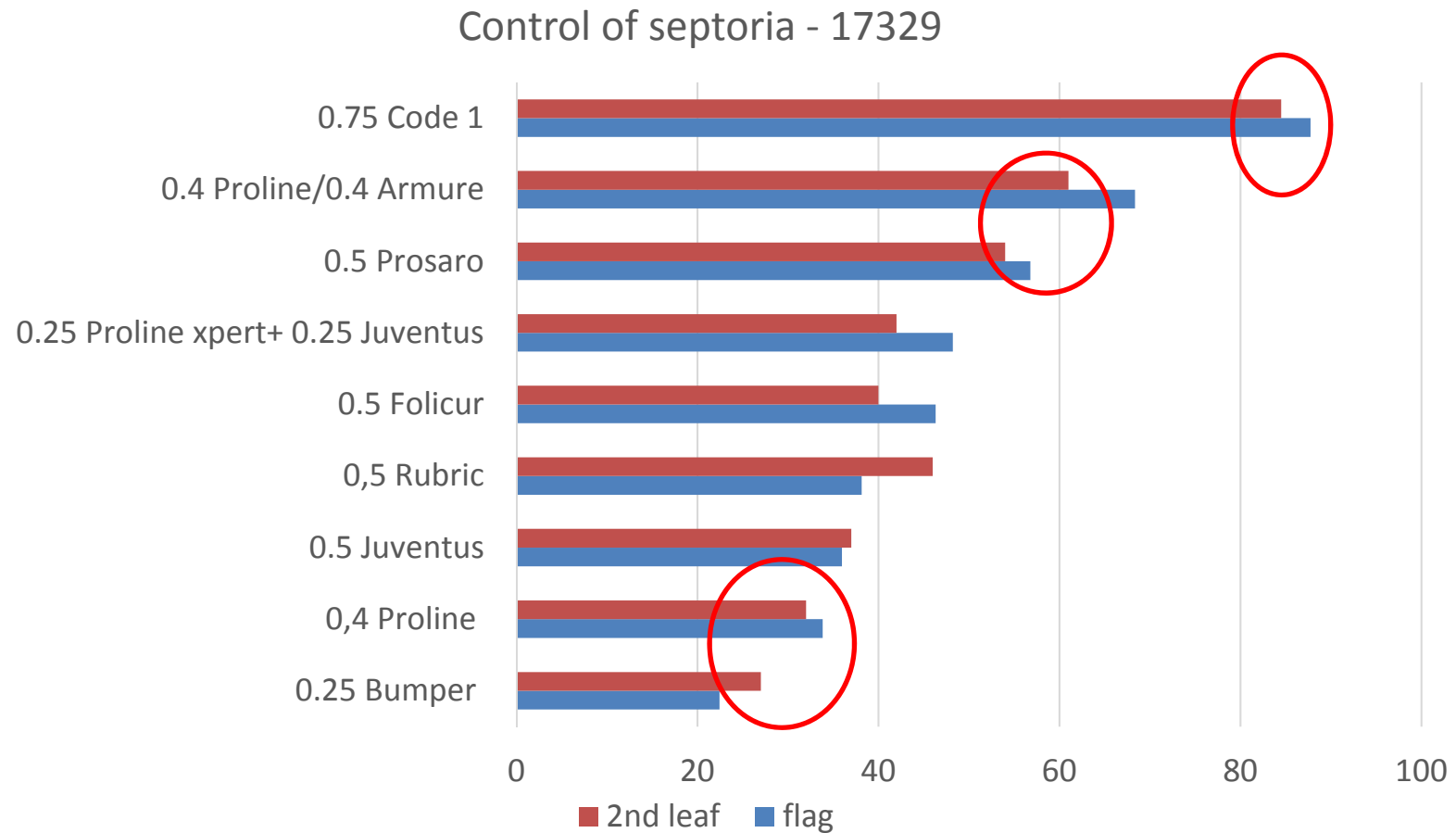


2 x 0.75 Code 1 (Revysol)



untreated

%Control of septoria 2 trials 17329



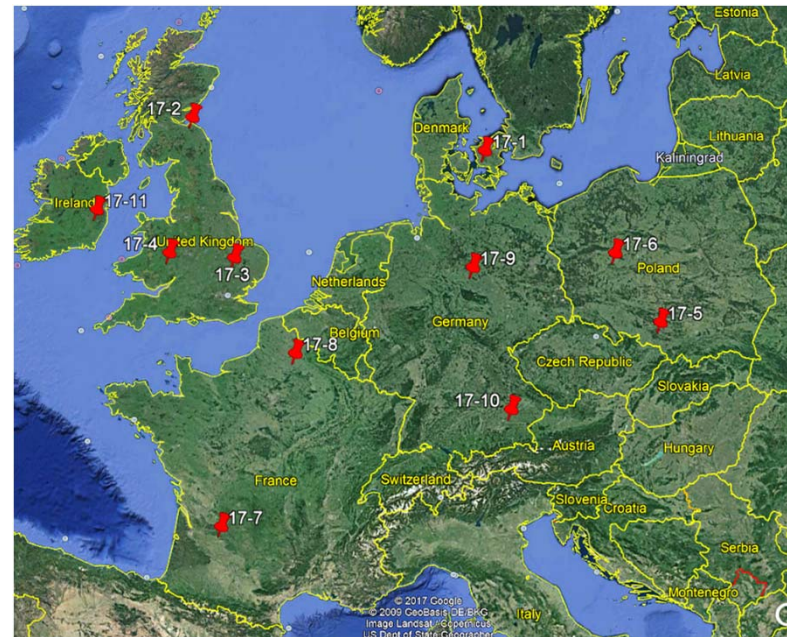
Flag leaf : 87% GS 77

2nd leaf : 48% GS 73

Partners in EuroWheat-project – Previous Endure - Partners

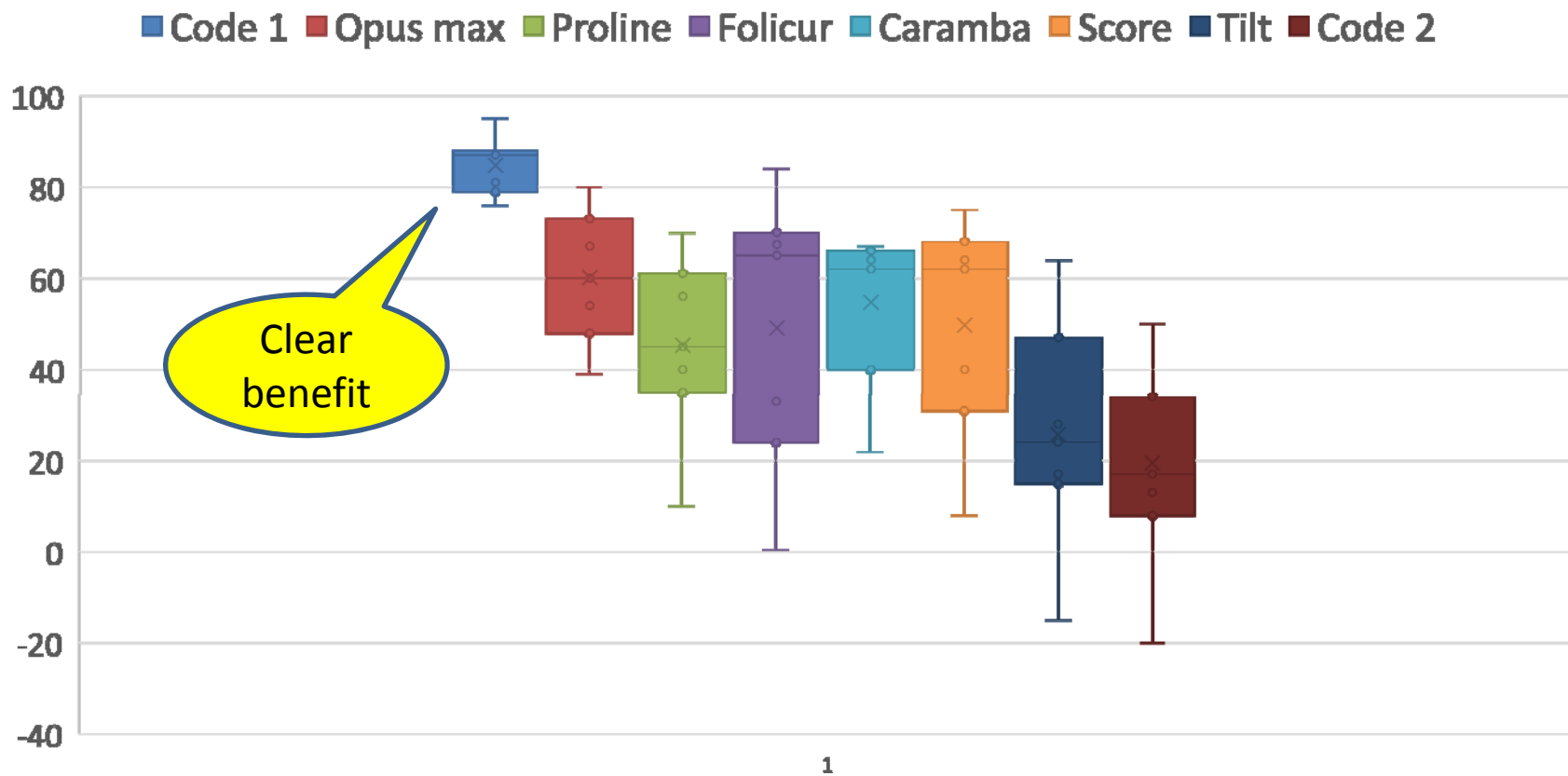


11 trials 2017



%Control of STB on 2nd leaf - 7 trials 2017

Control of Septoria on 2nd leaf 30-43 DAA



Yield increase (dt/ha) in 5 trials (1,4,5,10,11) dominated by septoria

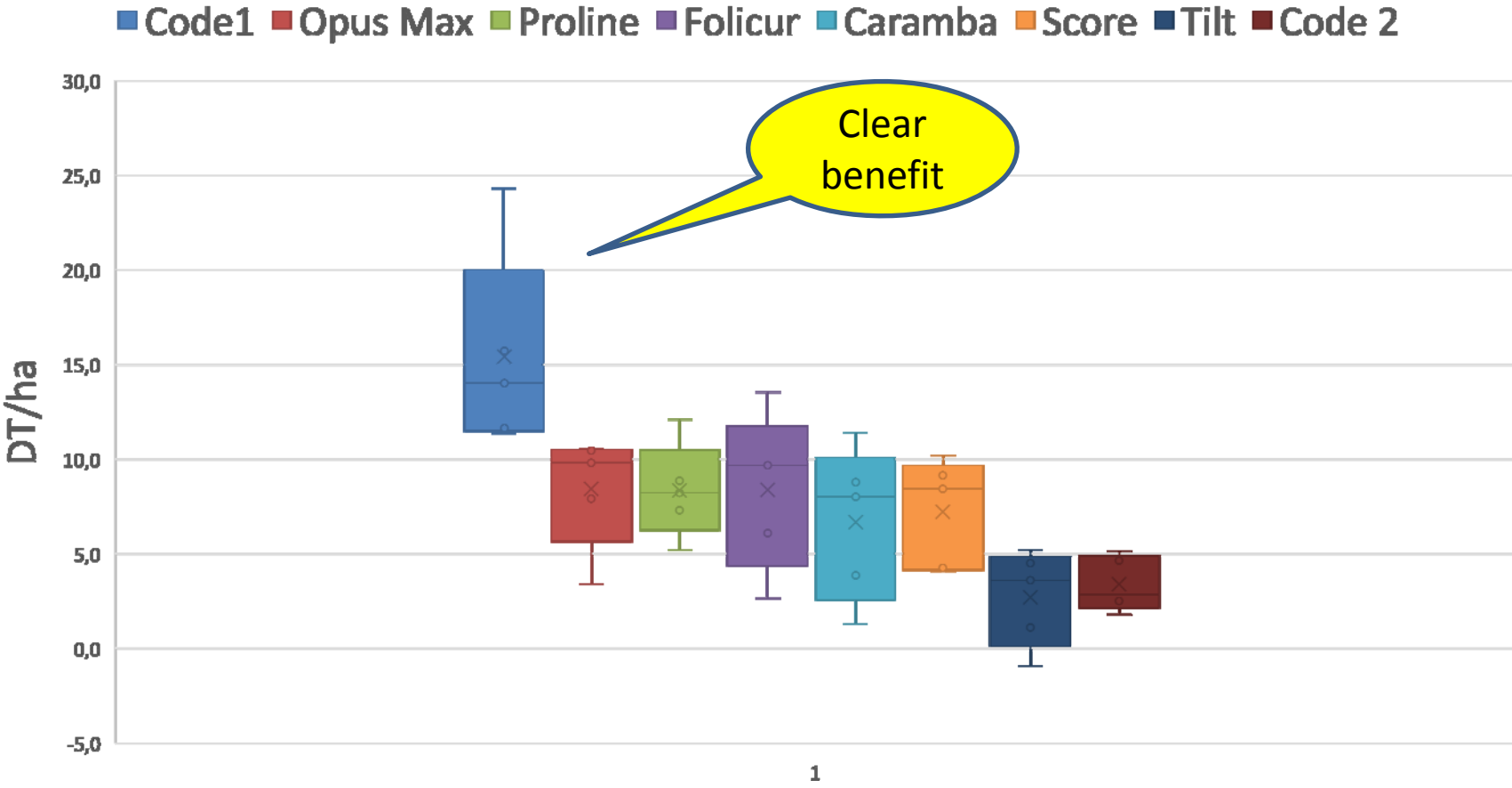


Bild 34

LNJ1

Lise Nistrup Jørgensen; 2017-10-10

Revysol – Styrker og udfordringer

Styrker

- Nyt aktivstof tilhørende triazolerne
- God effekt på septoria
- Virker effektivt på kendte CYP51 mutationer
- God blandingspartner til nye septoria-midler

Udfordringer

- Smalspektret – kræver blandingspartnere
- Ved ensidigt brug kan der udvikles nye mutationer!!!!

Forventes registreret til 2020 (2019)

Azol-situationen

- Septoria har udviklet resistens i de sidste år
- Der ses en reduktion i markeeffekten
- Svært at stoppe mutationsudviklingen!!
- Behov for større brug for alternativ kemi (SDHI'er, Inatreq, folpan)
- Stadig behov for azoler som blandingspartner til ny kemi
- Azolerne er under registreringsmæssigt pres – flere forventes udfaset i 2019-2020

Septoria in wheat

Forsøg 16338-1 - Hereford sprøjtet 4/5

1 x 0.8 Proline GS 31-32 (tr 7)

1 x 2,0 Inatreq GS 31-32 (tr 4)

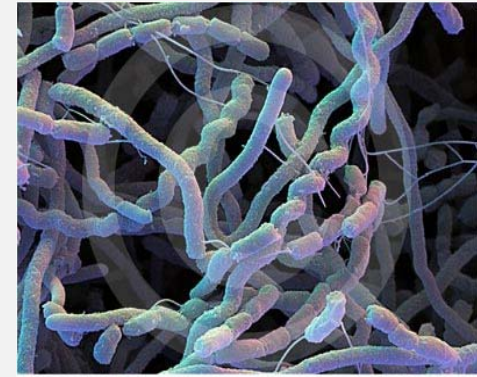


Foto: 7 July

Early treatments have long residual control of septoria

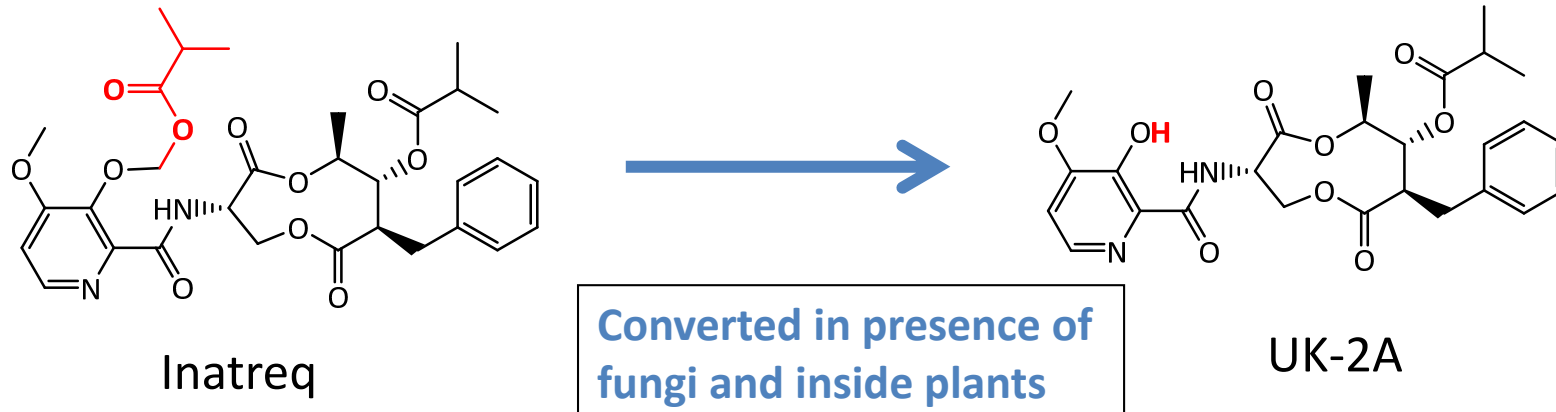
Inatreq™ Active is a new fungicide developed by Dow AgroSciences for control of Cereals Diseases

- NEW Chemical group: **Picolinamides**
- ISO common name: **Fenpicoxamid**
- **Novel chemistry with a NEW target site for cereal fungicides:** inhibits cell respiration in the mitochondria at Qi site of the respiratory cyt bc1 complex
- **No cross resistance** to current chemistries
- **Derived from a natural product (UK-2A)**, produced by fermentation of a strain of *Streptomyces sp. 517-02*
- **UK-2A is converted to Inatreq** through a single chemical modification step
- **Outstanding biological performance in field trials** on Septoria tritici blotch



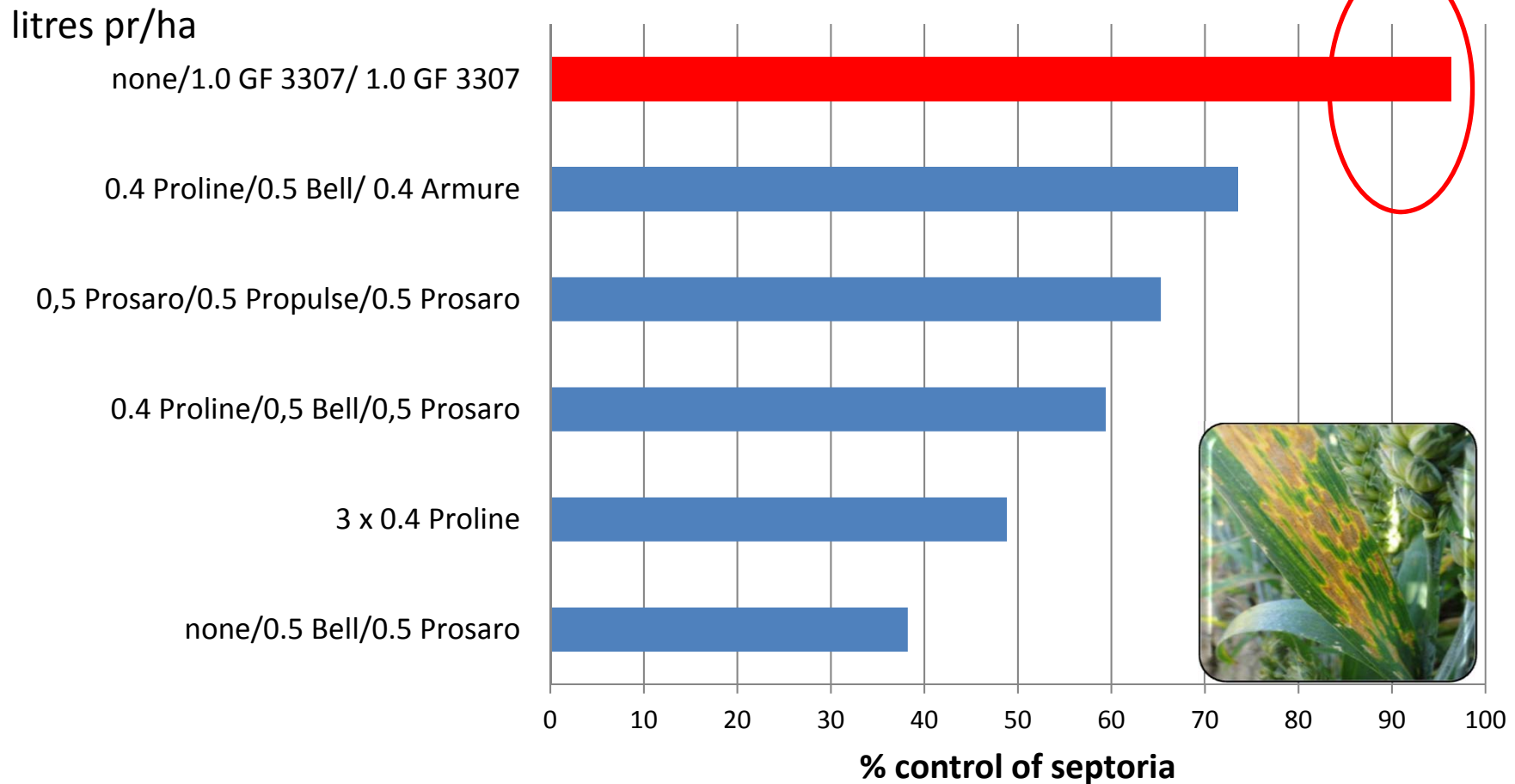
Streptomyces 517-02

Metabolism of Inatreq™ Active



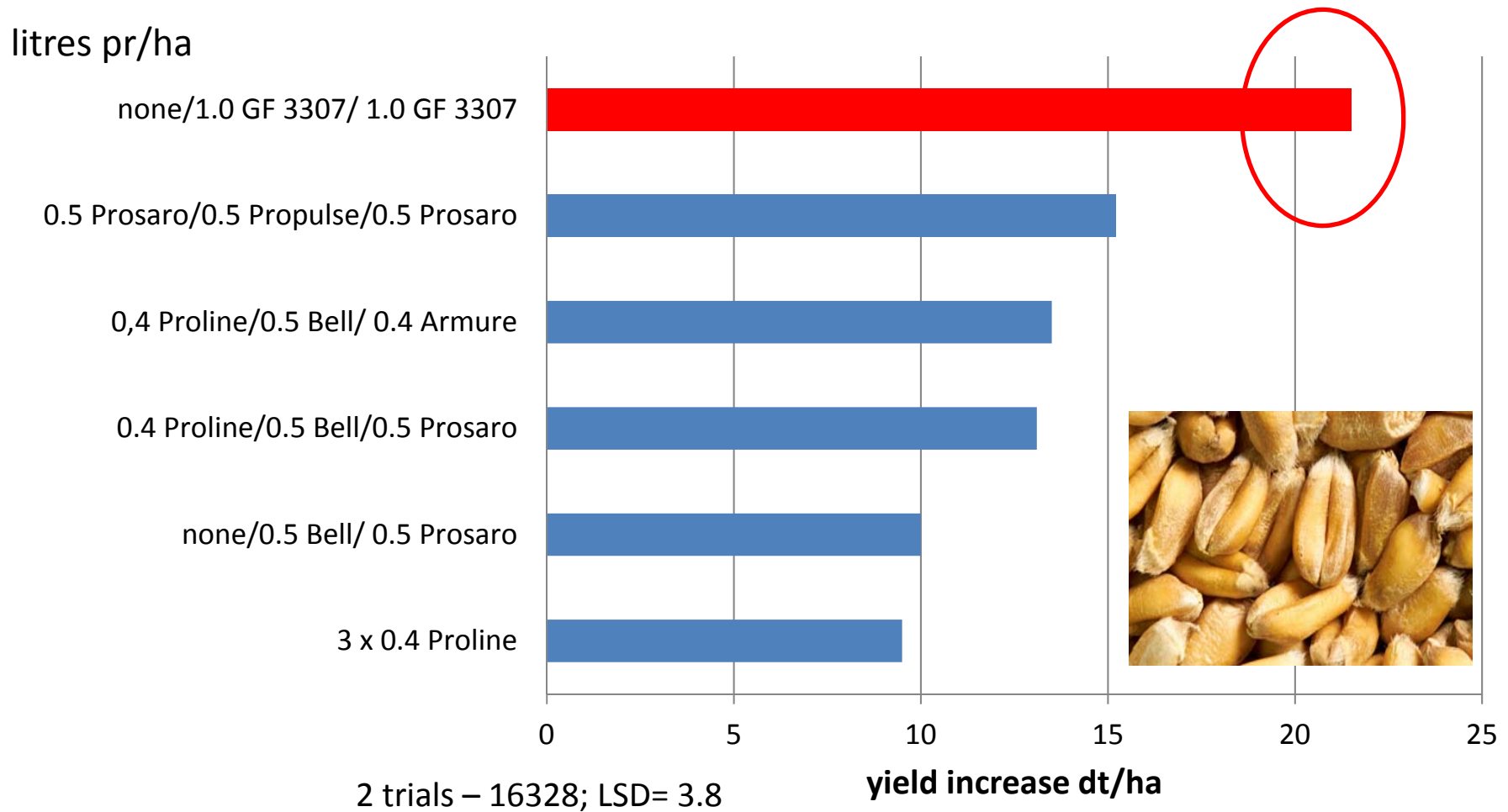
- Inatreq spray deposits on **leaf surface** are very stable: **Long Residual Protection**
- Inatreq on leaf surface is only converted to UK-2A once in the presence of fungi
- Inatreq continually penetrates into the leaf tissue from the leaf surface
- Inatreq rapidly converted to UK-2A in the plant and/or when taken up by fungal tissue within the leaf offering **Curative activity**
- Inatreq **is active on germinating spores, germ tubes and hyphae of fungi**

% Control of Septoria – Comparing Present Danish Solutions with Inatreq + Azole (GF-3307) Solutions; 2 or 3 x half doses



Assessed on flag leaf – average of 2 trials 16328

Yield responses (dt/ha) in wheat – – Comparing Present Danish Solutions Inatreq + Azole (GF-3307) Solutions; 2 or 3 x half doses



INATREQ – Styrker og udfordringer

Styrker

- Helt ny aktivstof gruppe
- Stor styrke på septoria
- Øger mulighederne for at diversificere

Udfordringer

- Smalsprektret og behøver blandingspartnere
- Mangler gode blandingspartnere til antiresistens



Do not be too keen to keep the crop clean!



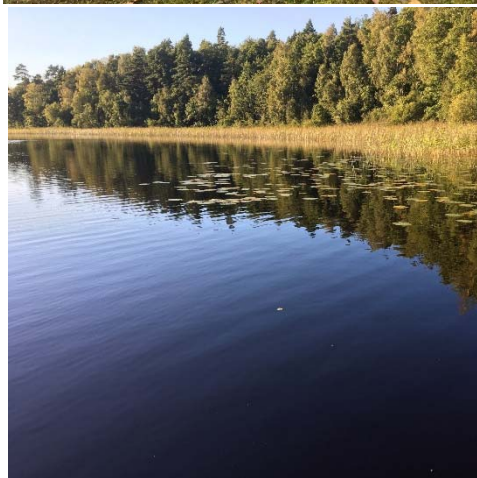
Reduce selection!

- Only spray when needed
- Do not be too keen to be clean!!!!
- Diversify the fungicides applied - use different Moa
- Preferably – only SDHI's once!!!
- Use mixtures or alternation
- Reduce rates if possible

Tak fordi I lyttede – tak til Sverige!



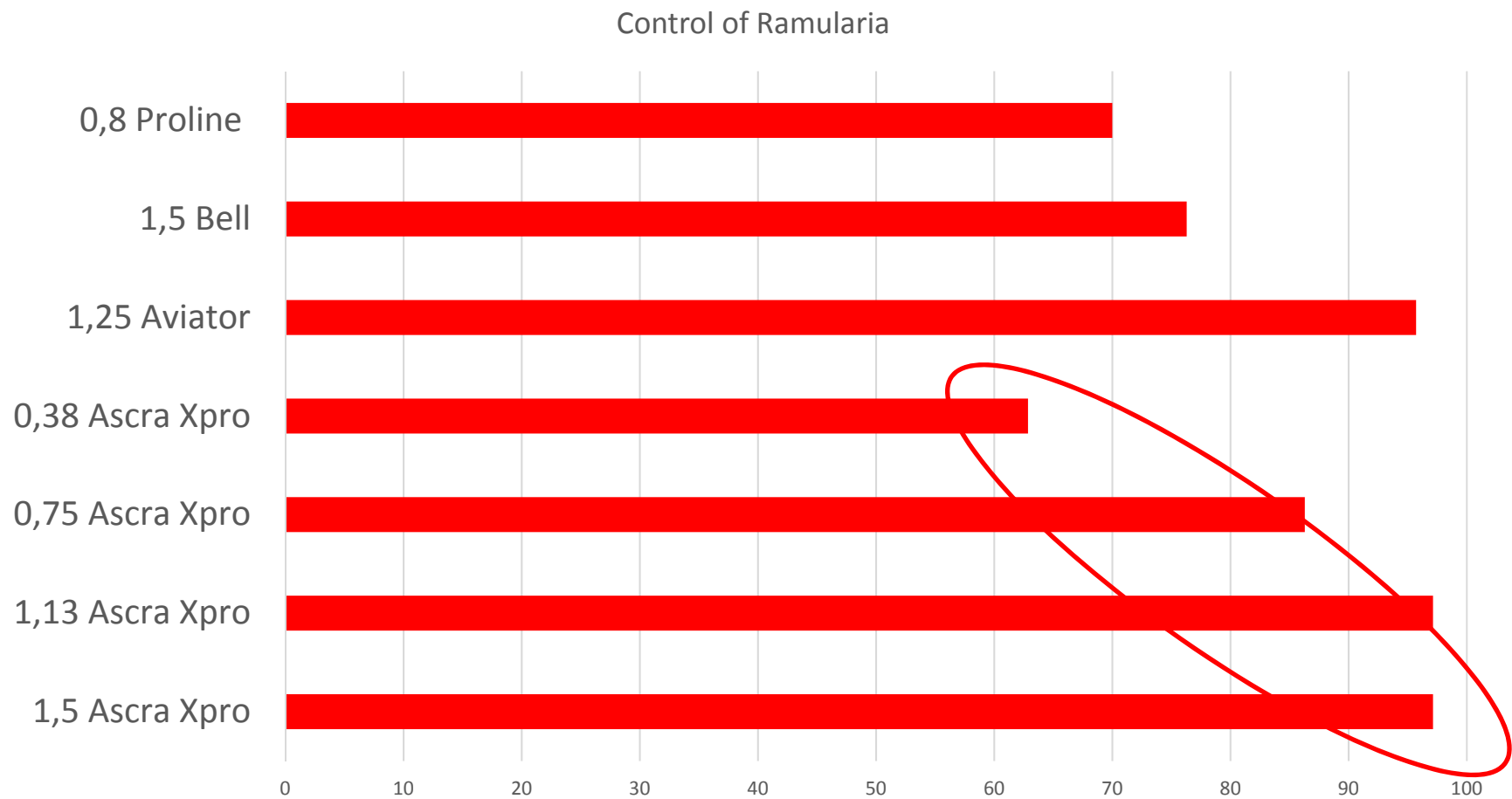
Håber ikke alle sopp bliver reduceret!!!



Lots of Ramularia leaf blotch



% control of Ramularia in spring barley 1 trial in 2013

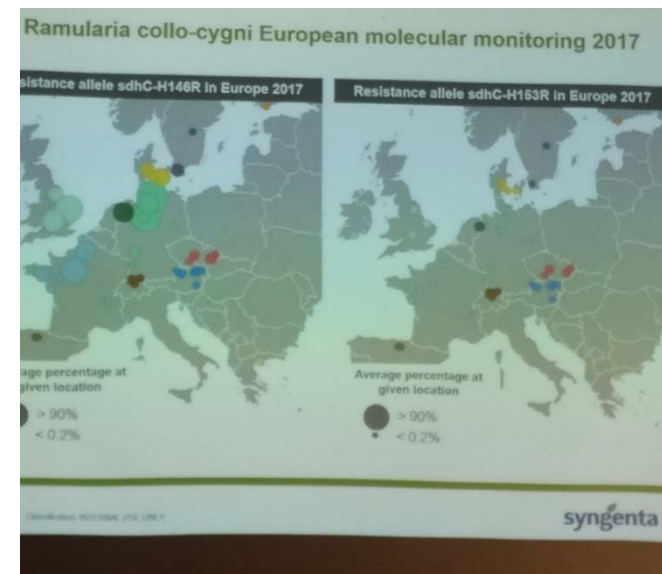
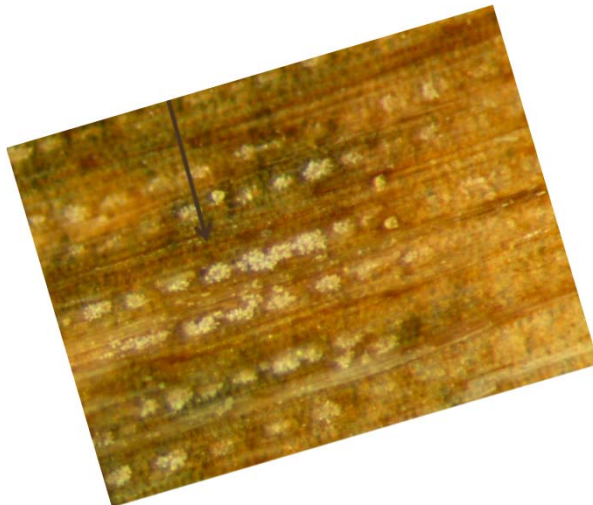


35% attack in untreated

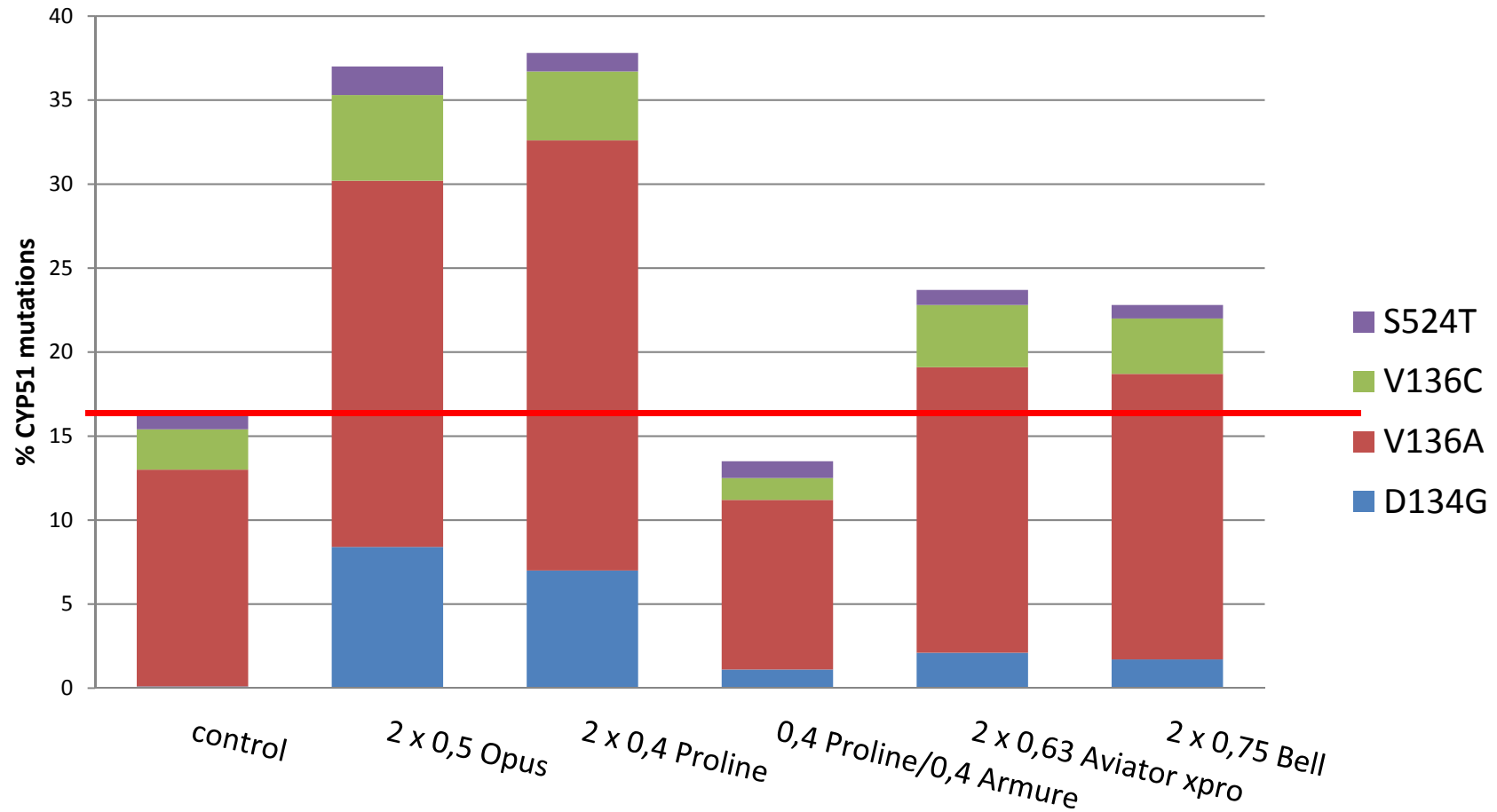
Resistance to Ramularia

MOA		
Azoles	CYP51 mutation, I325T (mostly in combination with T328L),	affecting particularly prothioconazole
Strobilurins	G143A	Major impact on efficacy
SDHI mutations	C-H146-R; C-H153R (C-H149R, C- C142R)	Major impact on efficacy

Many samples from NORBARAG will be investigated.



Changes in CYP51 – mutations with different control strategies – average of 9 field trials (DK, SW, Li)



Kilde : European Journal of Plant Pathology, Thies Wiczorek et al 2014,