



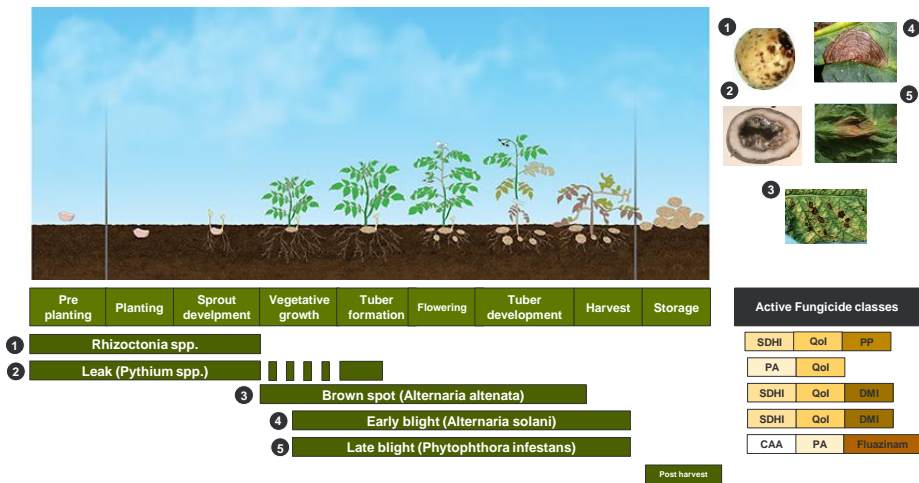
Monitoring 2016 syngenta

**Alternaria alternata and solani**

**Potatoes and tomatoes**

**Resistance evolution risk HIGH and MEDIUM**

**Potato growing stages and main fungal-oomycete diseases**





## Alternaria monitoring sampling 2016 from potato

Country	samples	isolates	A. alternata	A. solani
Belgium	7	41	4	37
Bulgaria	1	6	6	0
Czech Republic	1	6	0	6
Denmark	1	2	0	2
Finland	4	19	0	19
France	2	8	8	0
Germany	26	138	29	109
Greece	1	6	0	6
Hungary	2	11	10	1
Italy	2	12	0	12
Netherlands	1	3	3	0
Norway	0	0	0	0
Poland	5	29	11	18
Romania	3	15	8	7
Slovakia	3	18	12	6
Spain	1	6	0	6
Sweden	5	30	4	24
Switzerland	4	18	18	0
UK	1	1	1	0
<b>19 EU Countries</b>	<b>70</b>	<b>369</b>	<b>114</b>	<b>253</b>

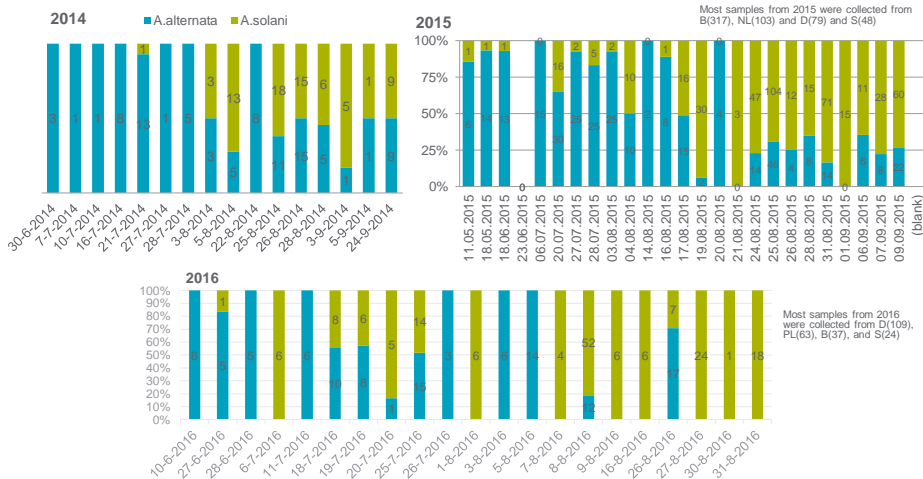


- A total of 70 samples (369 isolates) were monitored from 19 European countries
- 104 isolates were *A. alternata* and 253 *A. solani*

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### In our sampling : *A.solani* is mainly isolated from samples collected later in the season

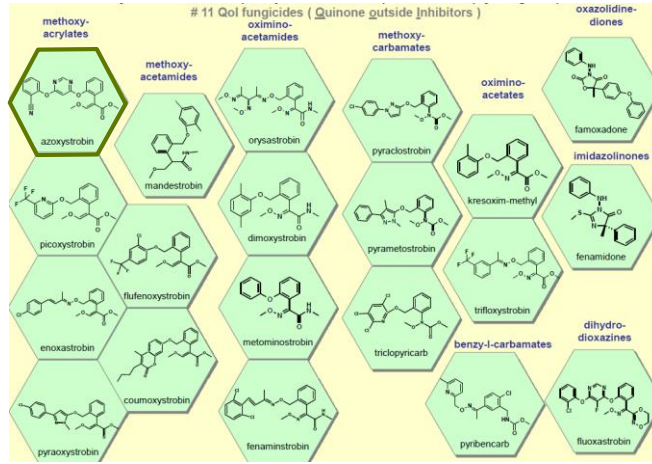


From early samples (June/July) *A. alternata* is predominantly isolated, whereas from the late samples an increased number of *A. solani* stains can be isolated. Occurrence of Alternaria species in samples might be country and season dependent

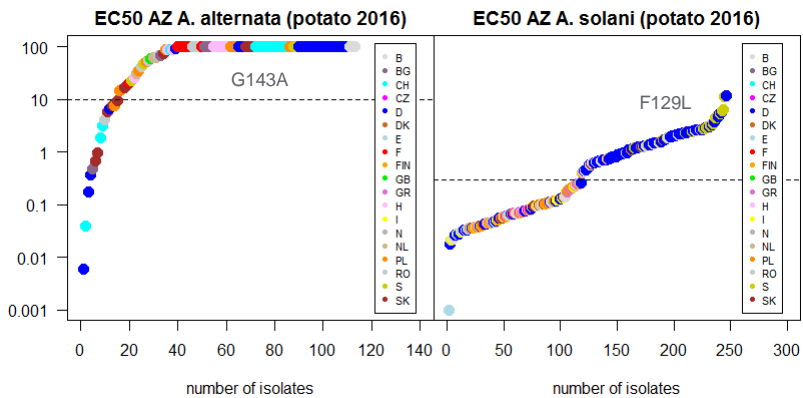
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# Qols



## Alternaria alternata vs solani AZ sensitivity (Potato 2016)

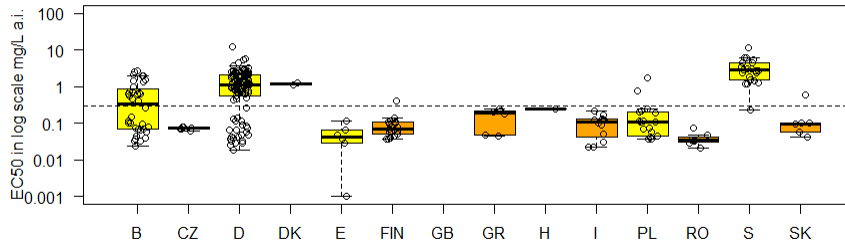


Qol resistance in *A. alternata* detected in most tested countries at moderate to high frequency  
*Alternaria solani* reduced sensitivity in (B, D, DK, FIN, PL, S, SK)  
*A. solani* low freq of Qol adaptation in FIN, PL, SK; medium frequency monitored in B, D, S, DK  
 No Qol adaptation was reported in CZ, E, GR, H, I, RO



## Alternaria solani AZ sensitivity (Potato 2016)

Geographic distribution of A. solani AZ sensitivity in 2016 (potato)

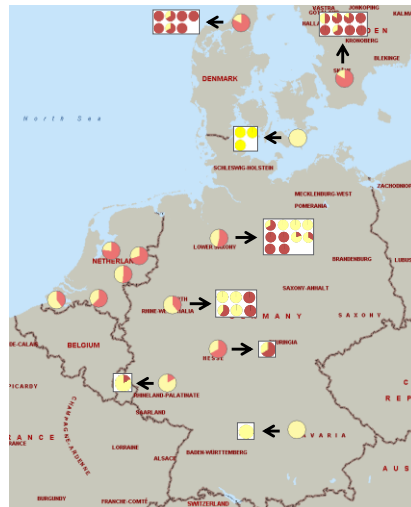


- **Low frequency of QoI adaptation** in FIN, PL, SK
- **Moderate frequency of QoI adaptation** in B, D, S, DK (in 2015 NL)
- **No QoI adaptation** was reported in CZ, E, GR, H, I, RO



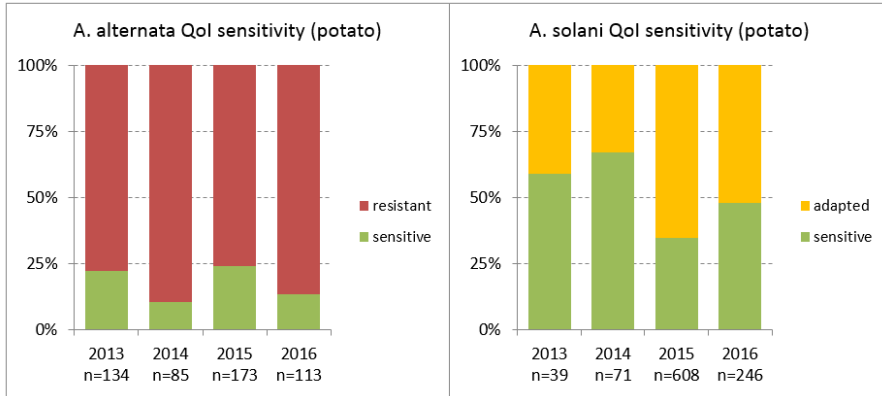
## Alternaria solani QoI resistance distribution in NL, DE, DK Monitoring 2015

- Through intensive monitoring carried out in The Netherlands, Germany and Denmark QoI adaptation was present at very heterogeneous levels, with values ranging from zero to high depending from the monitored regions.
- Populations broadly sensitive to QoIs were monitored in Countries with medium levels of less sensitive isolates, as DE, DK, BE
- Low frequencies of the adaptation were confirmed in Austria, Hungary and Slovakia.
- All samples tested from France, Greece, Italy, Spain, and United Kingdom were sensitive.



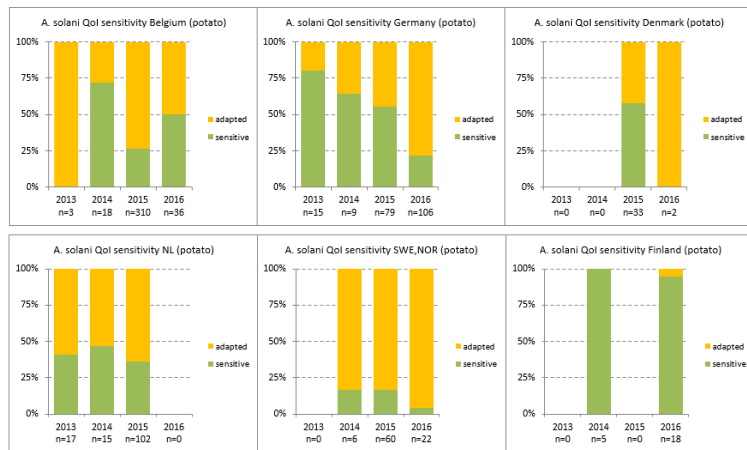


## Alternaria alternata vs solani AZ sensitivity evolution



Qol sensitivity is stable for the two pathogens from 2013 (fluctuation due to sampling)  
 A. solani Qol adapted isolates harboring F129L can be controlled by AZ robust dose

## Alternaria solani AZ sensitivity evolution



- No AZ adaptation monitored in CZ, E, GR, RO
- Low AZ adaptation monitored in: A, F, FIN, H, PL, SK
- Medium adaptation monitored in DK, B, D, N, NL, S (with heterogenous distribution)



Preliminary results Early blight, *Alternaria solani* by BASF, DuPont, Syngenta

Resistance to Qol is associated to the presence of the F129L mutation. As already observed with other pathogens, resistance factors are significantly lower in comparison with the G143A mutation and field performance of products used according to FRAC and Manufacturers' recommendations were reported as good



**Medium frequency** in Belgium, Denmark, Germany Netherlands and Sweden.

**Low frequencies** in Finland, Poland, Slovakia and United Kingdom.

**Full sensitivity** in Czech Republic, France, Greece, Hungary, Italy, Romania and Spain



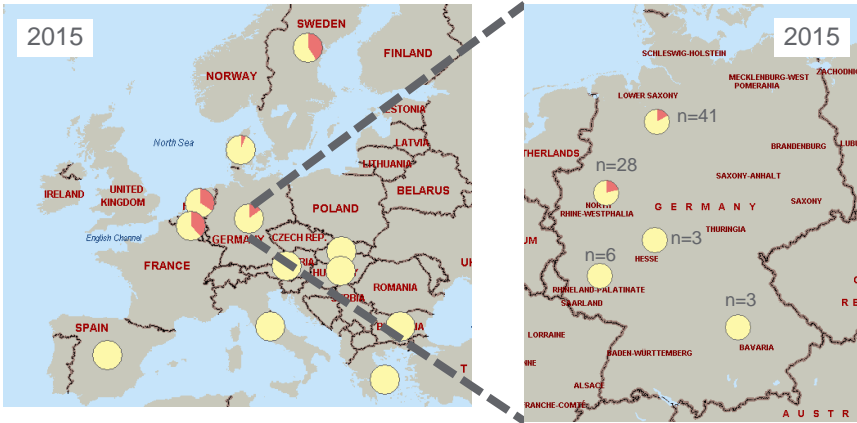
**Full sensitivity** monitored in Poland. Moreover in 2015 samples from Spain were sensitive



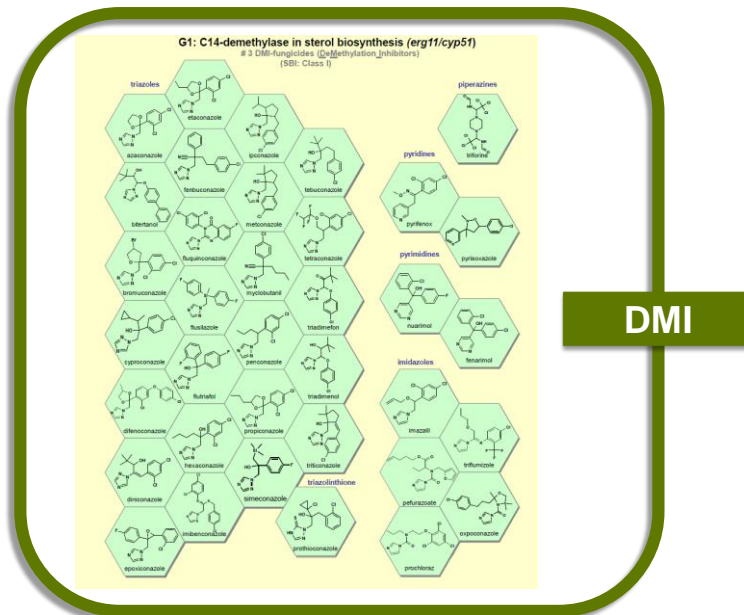
Qol Guidelines – Multi-spray crops (e.g. vegetables, including small berries and strawberries)

- Where Qol fungicide products are **applied solo** do not exceed **33% of the total number of sprays or a maximum of 4**
- Where **mixtures** (co-formulations or tank mixes) are used **do not exceed 50% of the total number of sprays or a maximum of 6 Qol fungicide applications**, whichever is the lower.
- **Where resistance has been confirmed**, Qol fungicides **must be applied only in mixture** with partners contributing to the effective control of the target pathogens

## QoI and SDHI double adaptation in *A. solani* from potato Monitoring 2015

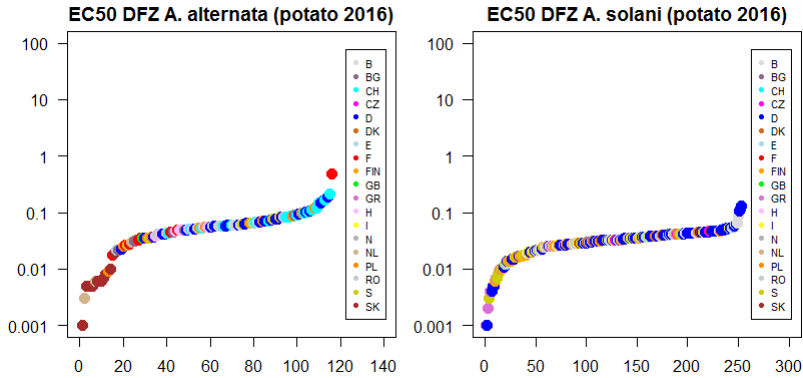


Double adapted strains can be found in populations at low to moderate frequency





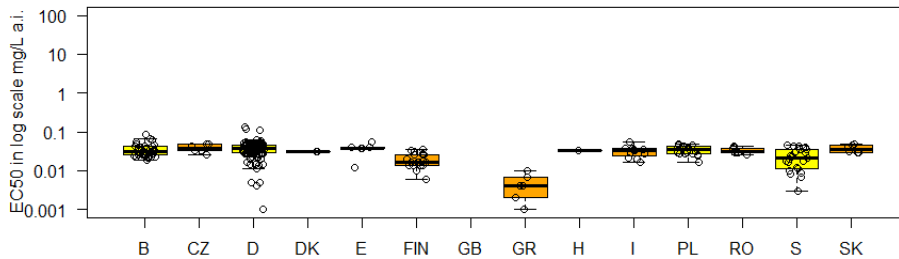
**Alternaria alternata vs solani DFZ sensitivity (Potato 2016)**



A single *A. alternata* isolate from F was slightly shifted, but in known sensitivity range



**Alternaria solani sensitivity to DFZ (potato 2016)**

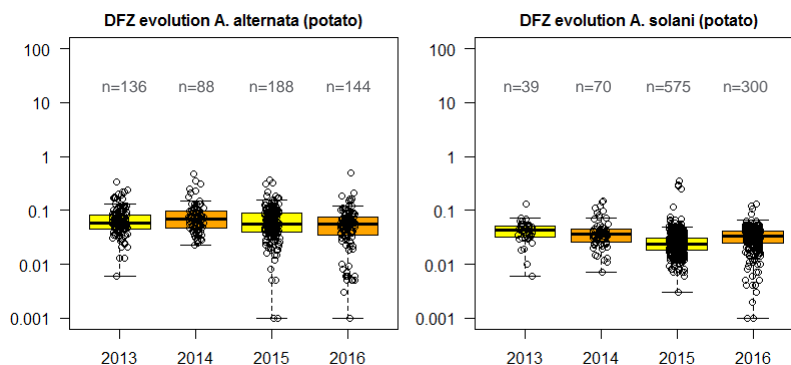


Homogenous sensitivity of *Alternaria solani* to difenoconazole was observed in different countries across Europe during 2016





## Alternaria species sensitivity evolution to DFZ in Europe



Stable *Alternaria* species sensitivity to DFZ compared to the past

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Results Early blight, *Alternaria solani* by Syngenta

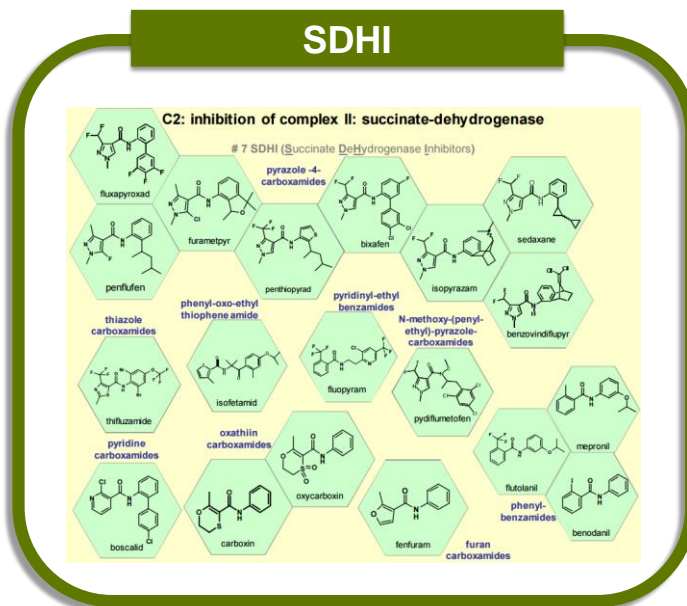
- Results for 2016 were presented and monitoring was carried out in Belgium, Bulgaria, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Italy, Lithuania, Netherlands, Poland, Romania, Slovakia, Spain, Sweden, Switzerland and UK
- Homogenous sensitivity of both *A. alternata* and *A. solani* was observed in different countries across Europe and **no change occurring in 2016**.

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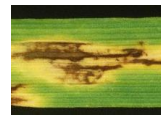
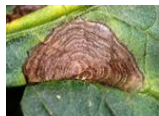
*Alternaria alternata* results available under [www.frac.info](http://www.frac.info)

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## SDHI



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Pathogen	FRAC risk	Host	Origin	Mutation
<i>Alternaria alternata</i>	HIGH	Potato, Pistachio, Cabbage	Field	B-H277Y/R/L, C-H134R, C-S135R, D-H133R/P/T
<i>Alternaria solani</i>	MEDIUM	Potato, Tomato	Field	B-H277Y/R, C-H134R, D-D123E, D-H133R
<i>Pyrenophora teres</i>	MEDIUM	Barley	Field	B-H277Y, C-K49E, C-R64K, C-N75S, C-G79R, C-H134R, C-S135R, D-D124N/E, D-H134R, D-D145G
<i>Zymoseptoria tritici</i>	MEDIUM	Wheat	Field	B-N225T, C-T79N, C-W80S, C-N86S, C-H152R, ...

- The evolution of **SDHI resistance** is more **complex** than for QoI (mainly G143A in cytb)
- Distinct species can **co-evolved** a similar panel of mutations at *sdh* target genes influencing fungicide sensitivity. Parallel genetic adaptation to SDHIs is influenced by selection imposed by fungicide application and genetic background at target sites

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## Frequency of SDHI resistance alleles detected in Belgium Landschoot et al. unpublished

**Table 2** Frequency (%) of the different SDHI mutants in the *A. solani* and *A. alternata* populations during 2014 and 2015 in Belgium.

<i>Sdh</i> subunit	Amino Acid change	<i>A. solani</i>		<i>A. alternata</i>	
		2014 (n=41)	2015 (n=42)	2014 (n=20)	2015 (n=33)
<i>SdhB</i>	H277Y	4.88	23.81	22.22	21.21
<i>SdhB</i>	H277R	0.00	2.38	0.00	0.00
<i>SdhC</i>	H143R	21.95	38.10	5.56	21.21
<i>SdhB</i> & <i>SdhC</i>	H277Y & H143R	36.59	9.52	0.00	0.00
<i>SdhB</i> & <i>SdhC</i>	H277R & H143R	0.00	2.38	0.00	0.00
<i>SdhD</i>	H133R	0.00	0.00	0.00	3.03
<i>SdhD</i>	D123E	0.00	0.00	0.00	6.06
<i>Wildtype</i>	-	36.59	23.81	72.22	48.48

- Most frequent mutations are in both *Alternaria* species *sdhB* H277Y and *sdhC* H134R



Results Early blight, ***Alternaria solani*** by Syngenta, BASF

**No resistance** in Czech Republic, Spain, Finland, Greece, Hungary and Slovakia.

**Low frequency of resistance** in Poland, Denmark, Italy, Romania and the UK.

**Moderate frequency of resistance** in Belgium, Germany, Netherlands and Sweden.

Moreover **in 2015**, no SDHI resistance was detected in *A. solani* in Austria and France. Isolates with reduced sensitivity were as well detected in Denmark.



No resistance was detected in Poland, Bulgaria, Italy and Spain in 2015 and 2016





SDHI Guidelines – Multi-spray crops (e.g. vegetables, including small berries and strawberries)

- When used in mixtures, the mixture partner:
  - should provide satisfactory disease control when used alone on the target disease
  - must have a different mode of action
- When as a **solo product**, the number of applications should be **no more than 33% of the total number of fungicide** applications per season, in strict alternation with other MoA
- When SDHI are used **in mixtures**, the number of SDHI containing applications should be **no more than 50% of the all fungicide applications** per season.
- In programs where SDHIs are made with both solo products and mixtures, the number of SDHI containing applications should be no more than 50% of all fungicides applied per season
- If used in mixture, apply SDHI fungicides in a maximum of 2 consecutive applications.

Total number of spray	1	2	3	4	5	6	7	8	9	10	11	12	>12
Max solo SDHI (strict alternation)	1	1	1	1	2	2	2	3	3	3	3	4	*
Max SDHI in mixture	1	1	1	2	2	3	3	3	3	3	4	4	*

## General Conclusion

- Major cause of early blight is *Alternaria solani*
- *A. alternata* is always present and can cause early blight dependent on the cultivar, region and yearly climatic condition
- *A. alternata* infect before *A. solani* during the season, however the pathogenic species complex is not completely understood yet. The timely appearance of *A. alternata* and *A. solani* could be used for spray program recommendations (DMI earlier than QoI and SDHI)
- SDHIs should be considered cross resistance, despite patterns of incomplete cross resistance have been reported in *Alternaria*
- Due to the risk associated to each fungicide class and the necessary measures needed to prolong their effectiveness it is important to adhere to the recommendations, but to include all possible MoA in a spray program