Gruppo di Lavoro Micotossine

Experiences on *Fusarium*-toxins management in Italy.

VII Fusarium toxin forum 2010

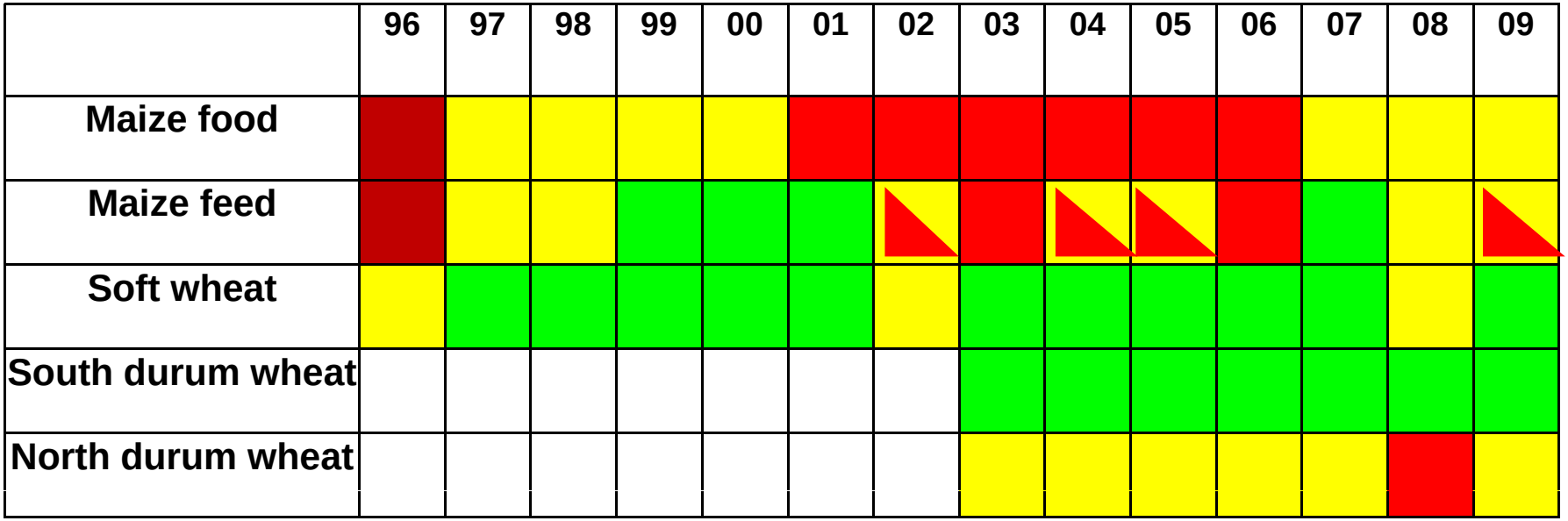
Management of *Fusarium* –toxins in cereals and cereal products

1- 2 February 2010

Prof. Roberto Causin

Gruppo di Lavoro Micotossine

Mycotoxins in Italian cereals



T-2 and HT-2 toxins: data not reported. National monitoring program is needed. Only few regional data are available. In Veneto region, north-east of Italy, T-2 and HT-2 are found at low level in wheat and at negligible level in maize.

Maize

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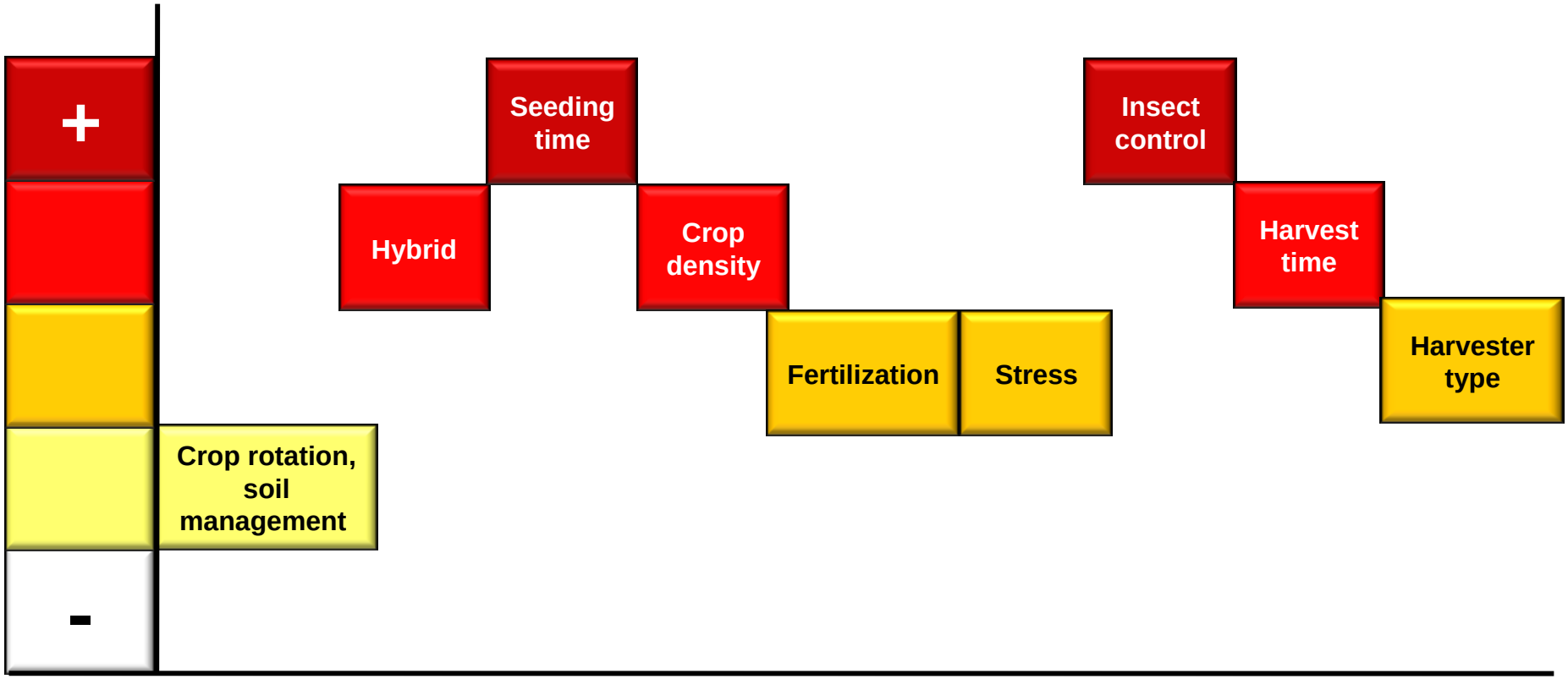
In Italian maize, fumonisins can be often present even at concentrations that make grain inadvisable for human consumption and feed of more susceptible animal species.

The introduction of maximum levels in commercial contracts and in EU legislation forced the maize chain to introduce GAP (Good Agricultural Practices) and GMP (Good Manipulation Practices) for the prevention and reduction of mycotoxins contamination in grains and related products.

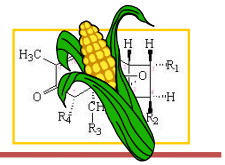
Maize agricultural practices were progressively introduced to reduce mycotoxin contaminations.

In order to reach lower contamination the following approach was used.

Agricultural practice effects on maize grain fumonisin contamination.



Reyneri et al., 2007



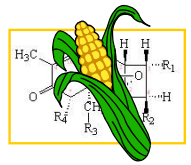
Anticipate flowering time “Early vigor”

	Early secondary soil tillage	Localized fertilization	Early nitrogen fertilization
Low input program	NO	NO	NO
Secondary soil tillage program	**SI**	NO	NO
Fertilization program	**SI**	**SI**	NO
Full program	**SI**	**SI**	**SI**

2009, 2 hybrids, 10 theses,
seeding time 20/3,
Ntot 220 kg/ha

	Flowering (d)	Yield (t/ha)	Grain moisture (%)	ECB damage index (%)	Ear rot index (%)
Low input program	104 a	14.1 b	26.1 a	52 a	45 a
Weeding program	104 a	14.5 b	26.2 a	53 a	39 b
Fertilization program	100 b	15.5 a	24.6 b	41 b	42 b
Full program	98 c	15.9 a	23.9 c	39 b	40 b
P-value	0,019 *	0.029 *	0.009 **	0,017 *	0,034 *

Reyneri et al. 2009



	"Careful" fertilization	"Simplified" fertilization
Sowing	18/4	20/4
	+ 6 d	
Flowering	13/7	21/7
	+ 1 d	
Harvest	1-5/10	1-13/10

Grain moisture (%)	18 - 20	25 - 27
Yield (t)	13 -15	11 -12
Fumonisins (ppb)	170 - 320	1230 - 2320

Reyneri et al. 2009

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Fumonisin risk management

Effect on fumonisin accumulation

Favorable to fungi development

Limiting fungi development

Control of fungi development

Agricultural practices	High Risk (HR)	Risk (R)	Correct (C)	Very Careful (VC)	Early vigor (EV)
Seeding time					
Planting density					
Nitrogen fertilization					
Corn borer management					
Early vigor					

GLM
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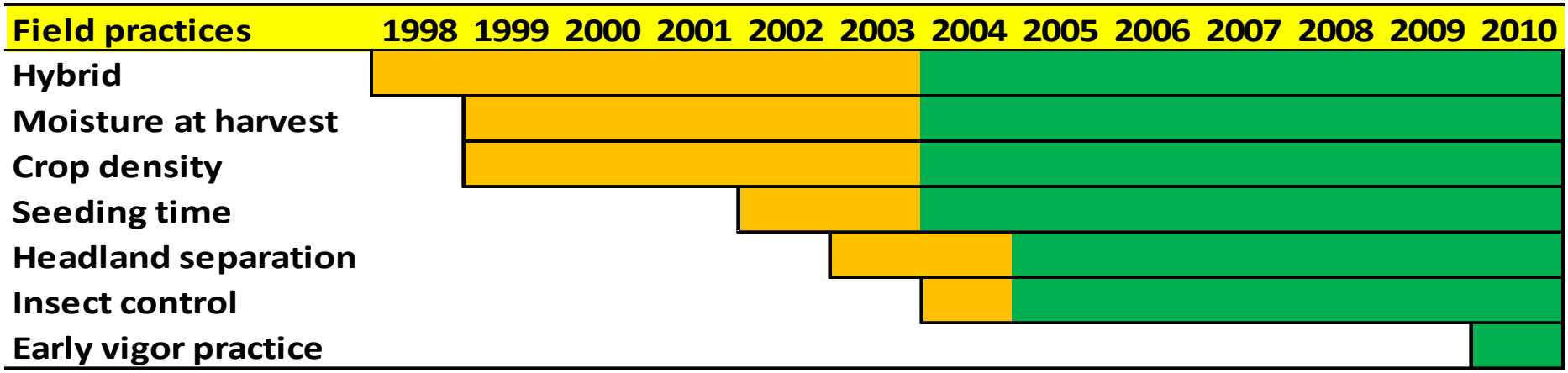
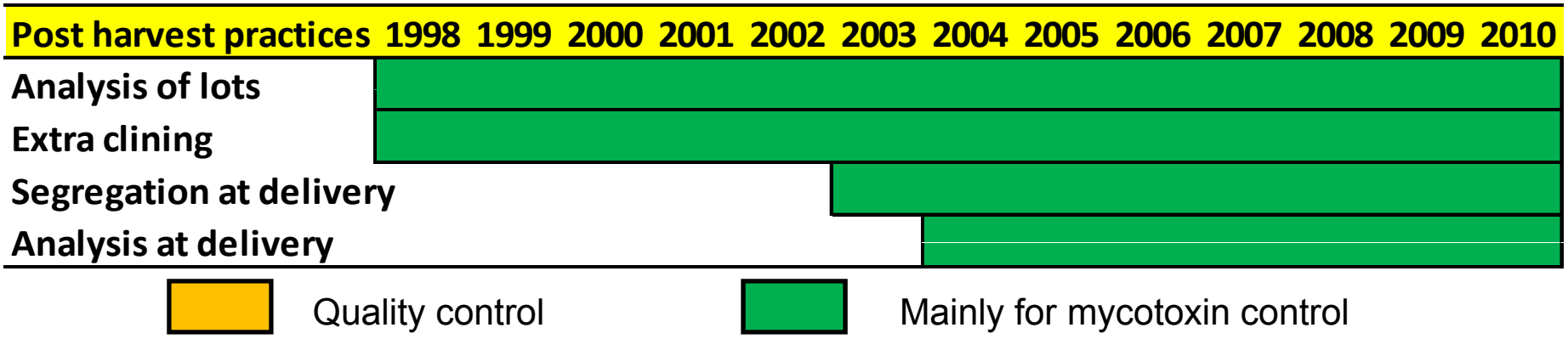
Year of introduction of Good Agricultural Practices:



Year of introduction of Good Manipulation Practices:



Analysis and segregation at delivery: the grain production of each field/farm is analyzed before drying. Between 2 or 3 categories are then pointed out.

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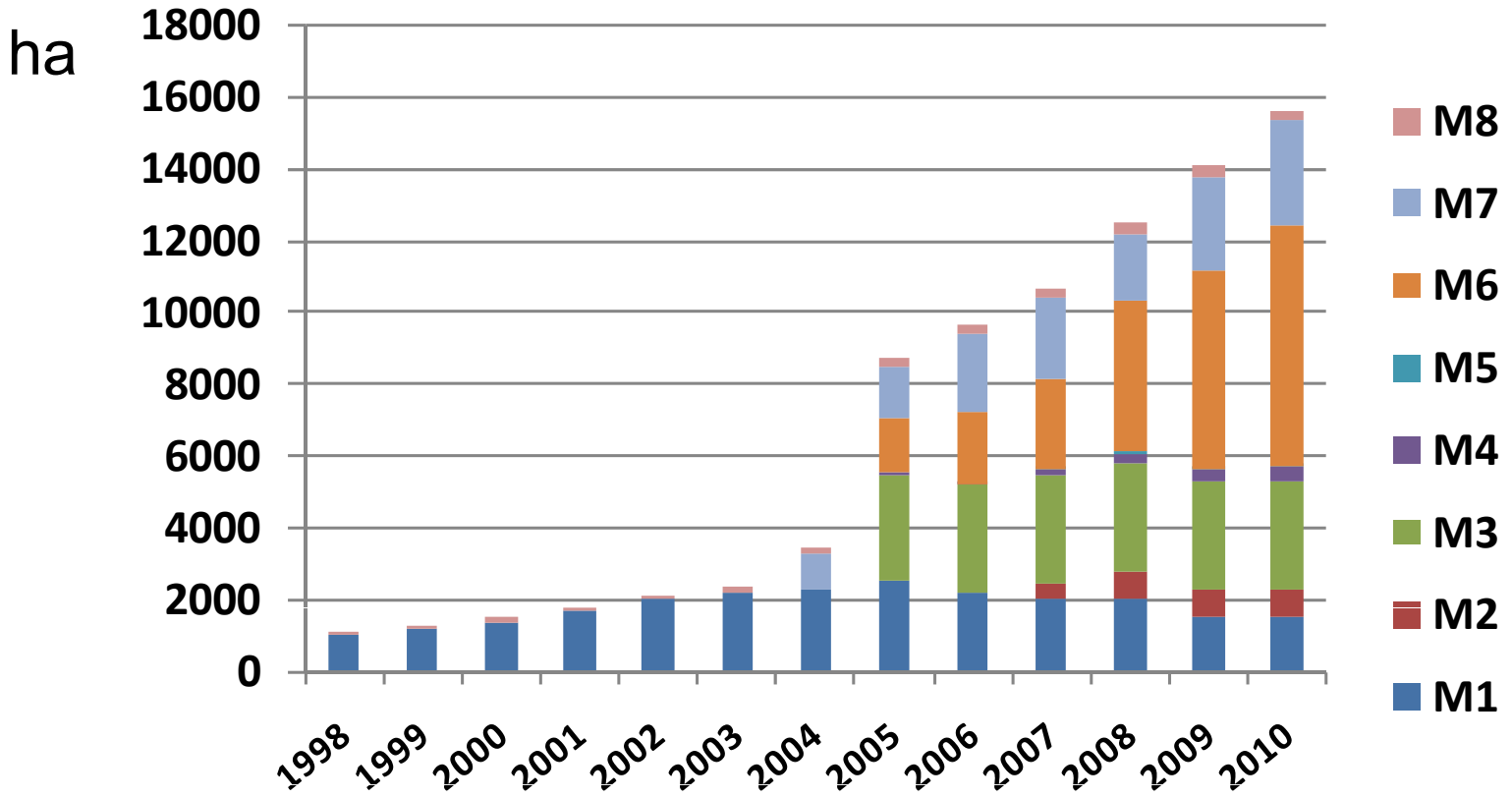
Evolution of the surface (hectares) with specific GAP for mycotoxin control subdivided in the 8 mills.



Nowadays the application of Good Agricultural Practices (GAP) followed by Good Manufacturing Practices (GMP) represents the only line of defence usable to control *Fusarium*-toxins contamination in maize grain.

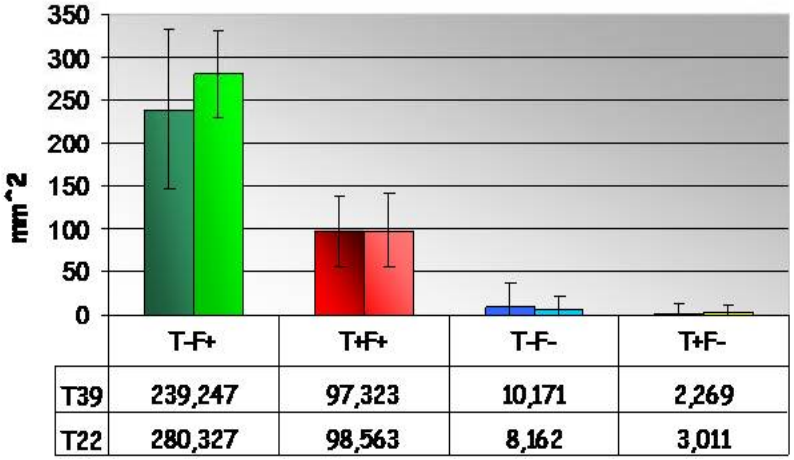
BUT

- Environmental condition highly favourable to *F . verticillioides* development;
- Annual fluctuation in weather;
- Logistic and organizational difficulties.

These aspects can reduce the advantage obtainable by the application of GAP in controlling fumonisin contamination maize grain.

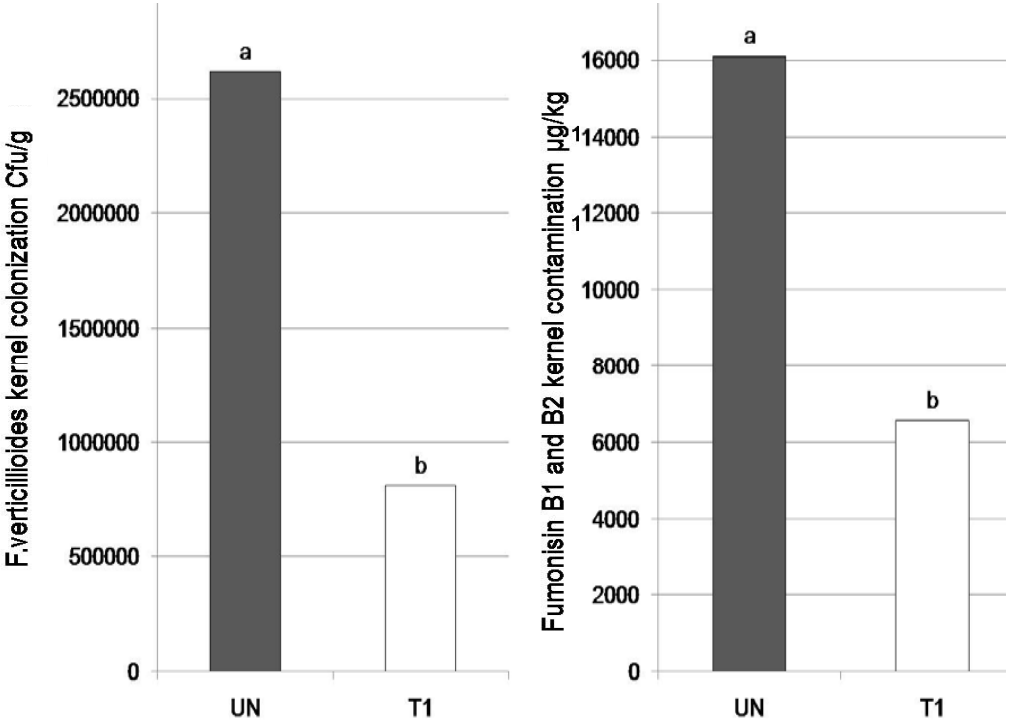
Direct control strategy: biological control

Effect of *T. harzianum* seed treatment on *F.verticillioides* symptoms



	T-F+	T+F+	T-F-	T+F-
T39	239,247	97,323	10,171	2,269
T22	280,327	98,563	8,162	3,011

Seed treatment with *T. harzianum* strain T22

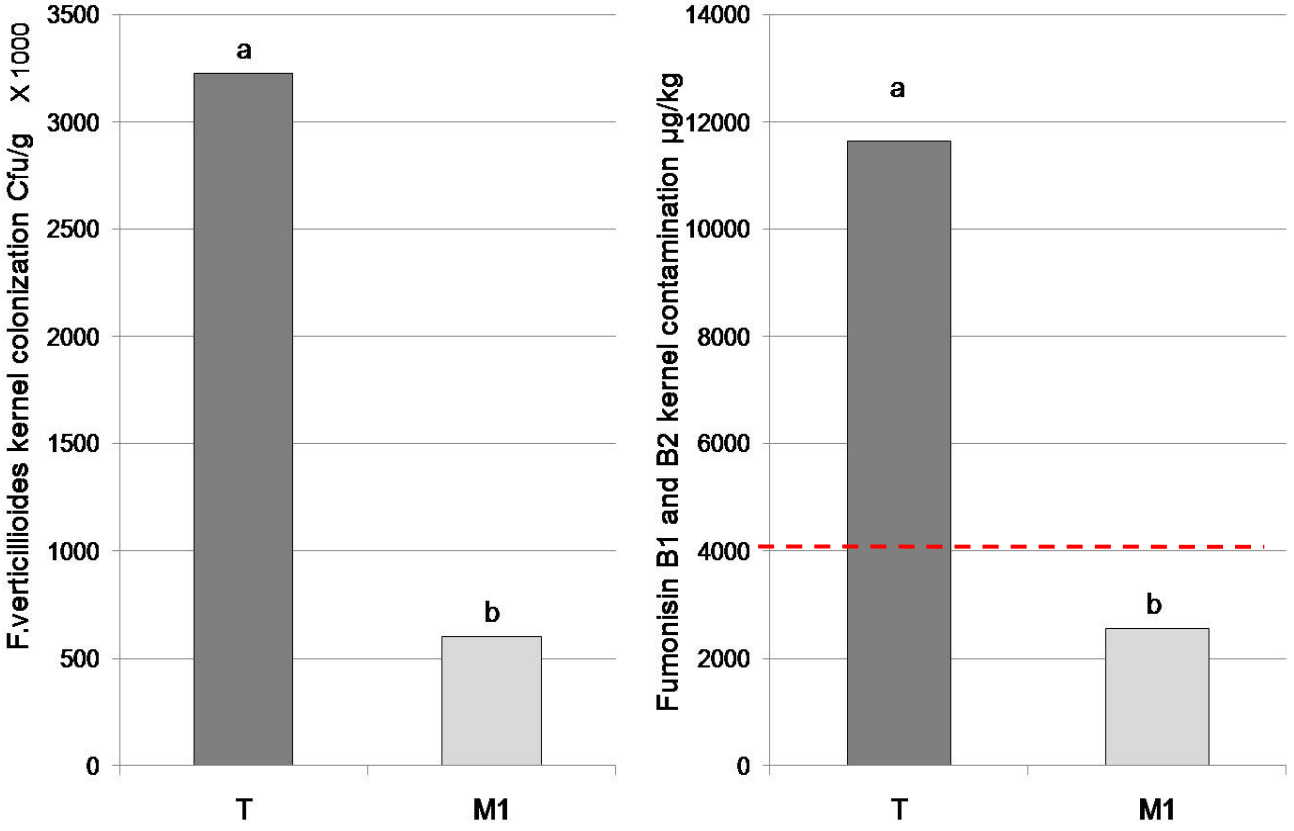


Means of 2 site and 3 years
UN: untreated
T1: seed treatment with *T. harzianum* T22

Causin et al. 2009

Direct control strategy: chemical control

Silk treatment seven days after female flowering



M1: mixture of Caramba® 90 G/L SL (Metconazole, w/w: 8,6%) and Sportak® 45 EW (Prochloraz, w/w:39,8%); Rate 1:1, 2l /ha in 600l water/ha.

Means of 3 site and 2 years

Causin et al. 2009

Environmental condition can modulate the effect of both chemical and biological control.

Why?

Some interesting aspects to be studied

1. Environment → *F. verticillioides*

2. Environment → Maize plant

3. Environment → Biological control agent

1. Environment → *F. verticillioides*

✓ Development
- Infection
- Competition with other fungal species

✓ Fumonisin synthesis activity

Can environment select *F. verticillioides* population with different biological characteristics?

ED_{50} in ppm

Strain	Sportak ED_{50} ±95% CF	Caramba ED_{50} ±95% CF	Mean
CBS 218.76	60,94 ±18,34	69,39 ±3,95	65,17
G1	13,51 ±6,21	2,27 ±0,58	7,89
KSU A-0999	55,75 ±29,90	14,83 ±2,54	35,29
Mean	43,40	28,83	

F. verticillioides fumonisin production at 25°C after 15gg

Monoconidial culture	Fumonisin production capability ppb/ mg of dried mycelium
1C	9,54
7B	64,78
10B	35,70
20B	0,24

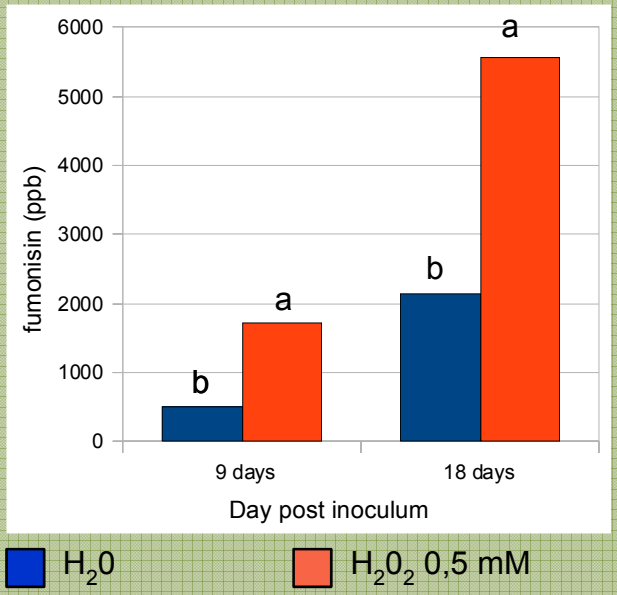
2. Environment → maize plant

- ✓ abiotic stress
- ✓ biotic stress → insect + other pathogens

→ **ROS**

- ✓ fitness → susceptibility to fungal infection
- ✓ fitness → energy availability

Reactive Oxygen Species ROS and fumonisin production



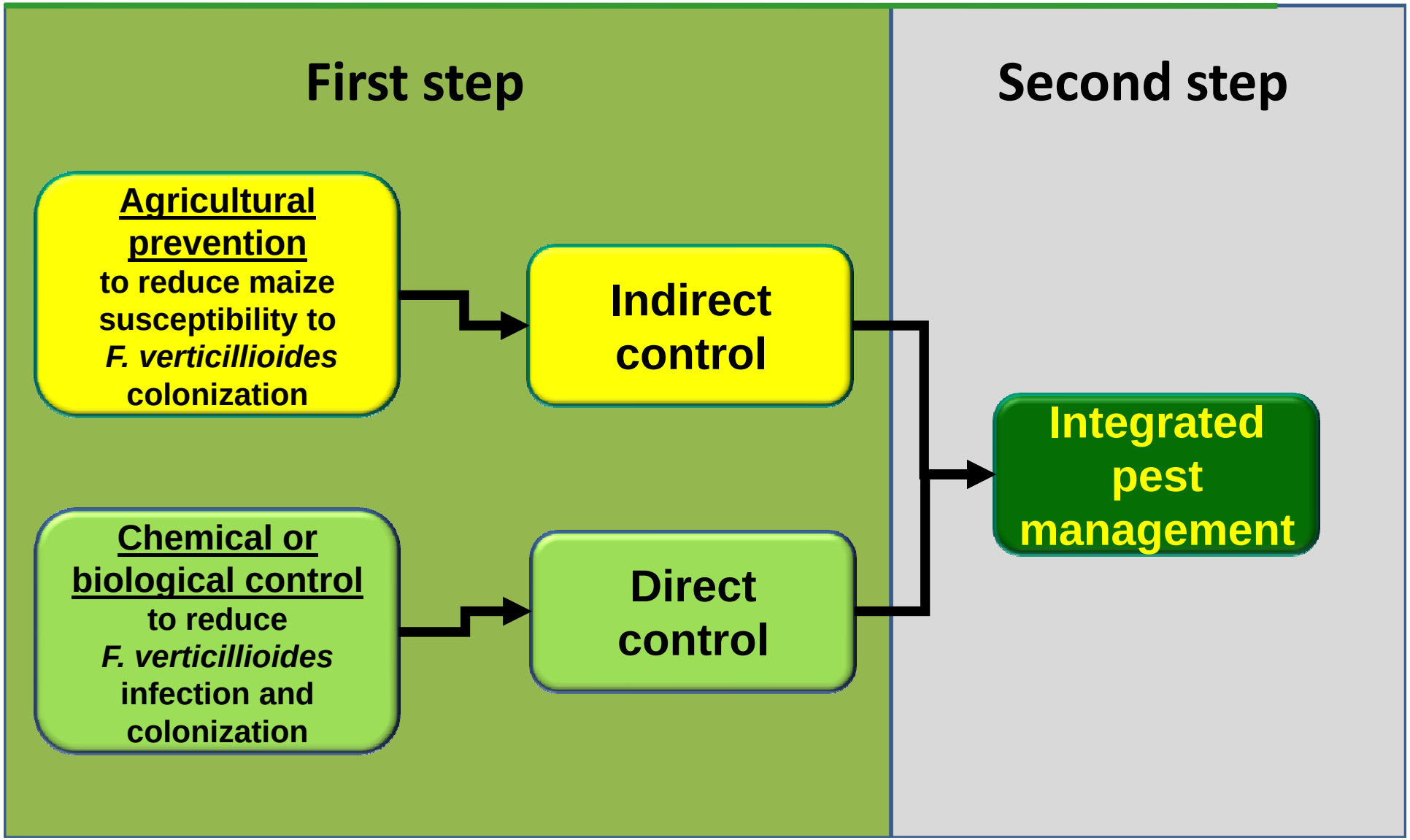
→ induced systemic resistance (ISR) response

3. Environment → biological control agent

Inoculation, development, persistence

Causin et al. 2009

The future


First step
Second step
Agricultural prevention to reduce maize susceptibility to F. verticillioides colonization
Indirect control
Chemical or biological control to reduce F. verticillioides infection and colonization
Direct control
Integrated pest management

Conclusions

1. Interactions between plant – pathogens - control practices are modulated by environmental condition. Studies on these aspects are only at the beginning and must be carried on in order to discover the chances and limits of integrated pest management protocols.

2. The application of GAP, GMP and direct control strategies increase production cost but at the present the low maize price discourages the application of careful agricultural production protocols.

At the moment the possibility to control mycotoxin contaminations on cereals is rather poor and further researches are required. Thus, it is appropriate to maintain the current regulation for next years.

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Thank you for your attention!

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