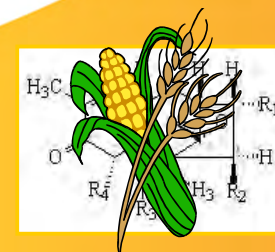


Progetto RQC - Mais



Micotossine emergenti nel mais: monitoraggio, prevenzione e ricaduta sulle filiera

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**UNIVERSITÀ
DEGLI STUDI
DI TORINO**



**Ministero delle
politiche agricole
alimentari e forestali**

Roma

28 novembre 2016

O=C(O)C[C@H](Cc1ccccc1)NC(=O)c2cc(Cl)c3c(c2)c(=O)OCC3=O

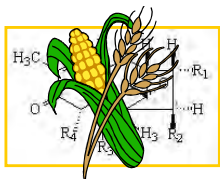
The chemical structure shows a complex bicyclic system. It features a carboxylate group (CH₃CH₂COO-) attached to a ring. There is a hydroxyl group (OH) and an ether bridge (O) in the bicyclic framework. A side chain includes a methyl group (CH₃) and a carbonyl group (C=O). The structure is labeled with 'OR' and 'H' to indicate stereochemistry.

T-2 Toxin: R = Ac
HT-2 Toxin: R = H

CC1(CCCC/C=C/C2C(=C(C=C2)O)C(=O)O1)C

The chemical structure shows a complex polycyclic molecule. It features a central six-membered ring with a ketone group (=O) and a methyl group. This ring is fused to a five-membered ring containing an oxygen atom. Another five-membered ring is fused to the side, also containing an oxygen atom. There are two hydroxyl groups (-OH) attached to the structure, one on a double bond and another on a saturated carbon. A methyl group is also present on one of the saturated carbons. The stereochemistry is indicated with wedges and dashes.

CCCCC(OC(=O)CC(C(=O)O)CC(C(=O)O)C)C(C)OC(=O)CC(C(=O)O)CC(C(=O)O)C(C)CCCCC(R1)C(R2)C(N)C



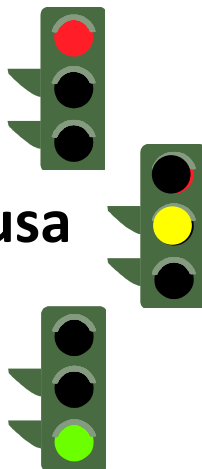
Presenza delle principali micotossine

Contaminazione: mais granella

- Elevata e diffusa

- Elevata ma non diffusa

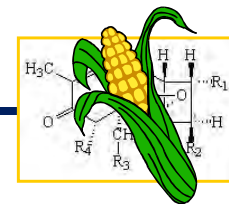
- Bassa e non diffusa



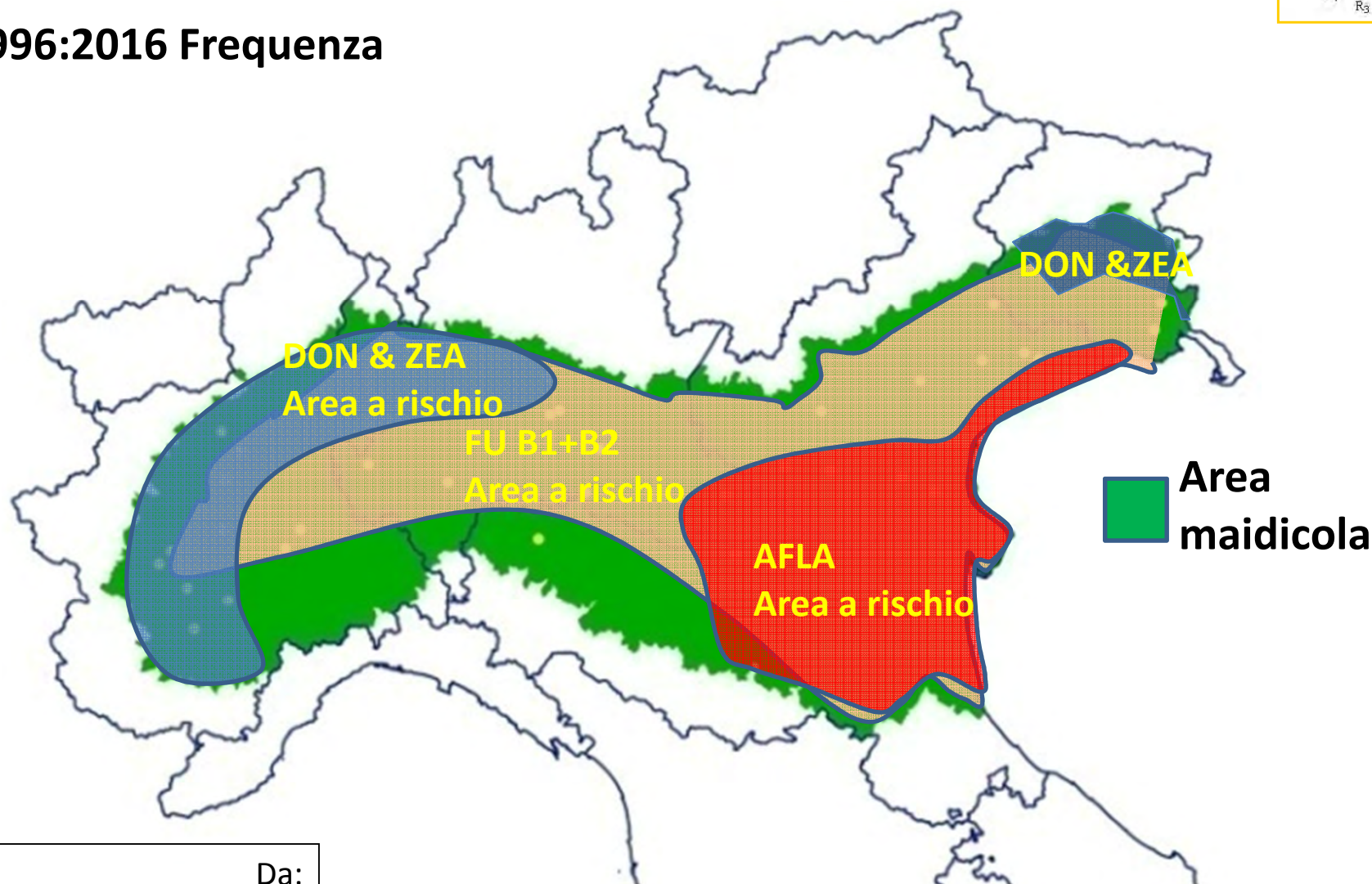
Da:
CRA-MICOPRINCEM,
RQC- Mais e DISAFA
dataset

Year	AFB1	FU B1+B2	DON - ZEA
1996	Green	Yellow	Red
1997	Green	Yellow	Green
1998	Green	Yellow	Green
1999	Yellow	Green	Green
2000	Green	Green	Green
2001	Yellow	Yellow	Green
2002	Green	Red	Red
2003	Red	Yellow	Green
2004	Yellow	Yellow	Green
2005	Yellow	Red	Yellow
2006	Green	Red	Green
2007	Green	Green	Green
2008	Yellow	Yellow	Green
2009	Green	Green	Green
2010	Yellow	Yellow	Yellow
2011	Green	Green	Green
2012	Red	Red	Green
2013	Yellow	Yellow	Yellow
2014	Green	Yellow	Red
2015	Green	Green	Green
2016	Yellow	Yellow	Green

Maize – post harvest survey

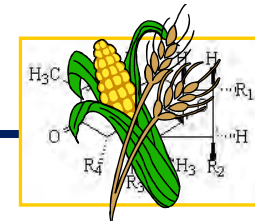


1996:2016 Frequenza



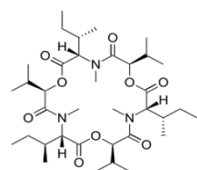
Da:
CRA-MICOPRINCEM,
RQC- Mais e DISAFA
dataset

Micotossine “Nuove” o “emergenti”

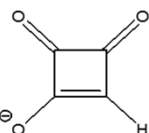


Circa 400 micotossine sono attualmente identificate

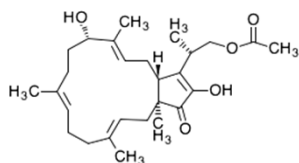
Micotossine “**nuove**” or “**emergenti**”: quelle che non hanno ancora ricevuto un’attenzione scientifica adeguata (Streit et al. 2013)



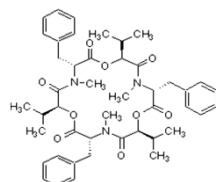
**Enniatine
(ENNs)**



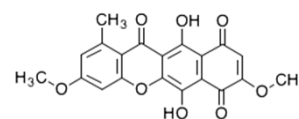
**Moniliformina
(MON)**



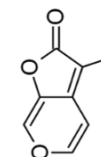
**Fusaproliferina
(FUS)**



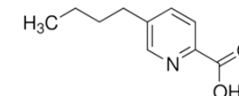
**Beauvericina
(BEA)**



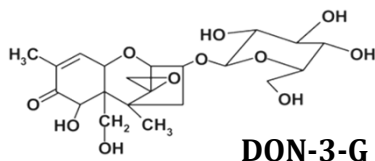
**Bikaverina
(BIK)**



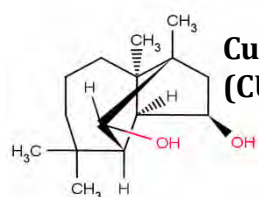
**Butenolide
(BUT)**



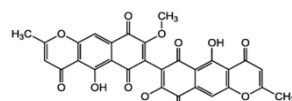
**Acido fusarico
(FA)**



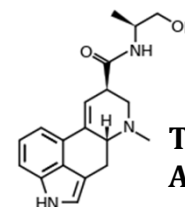
DON-3-G



**Culmorina
(CULM)**

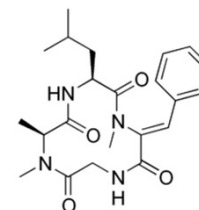


Aurofusarina (AUR)



**Tossine da
Alternaria**

**Alkaloidi
dell'Ergot**

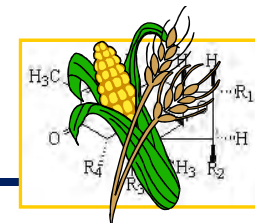


Richiesta per opinioni scientifiche sul rischio per la salute pubblica e animale correlate con la presenza di micotossine emergenti negli alimenti (feed e food).

☐ Presenza nelle materie prime e nelle produzioni delle diverse catene alimentari

☐ Condizioni che promuovono la loro presenza nel campo e nel post-raccolta

Raccolta di campioni e metodi di analisi



Indagine du mais granella in
silo (2014-16)



Number of samples:

200

Da campi sperimentali

mais



2008 - 2015

270

frumento



2010 - 2015

145

Mulino: farine, fiocchi



2011 - 2014

105

Metodo Multi-Mycotoxin

295 metaboliti di batteri e funghi

ESTRAZIONE da granella macinata :

$\text{CH}_3\text{CN}/\text{H}_2\text{O}/\text{CH}_3\text{COOH}$ (79:20:1 v/v)

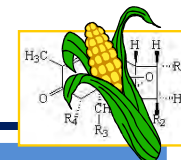
DILUIZIONE 1:2 by $\text{CH}_3\text{CN}/\text{H}_2\text{O}/\text{CH}_3\text{COOH}$ (20:79:1 v/v)

Analisi LC-MS/MS con Qtrap 5500 LC-MS/MS System (Applied Biosystems) munito di TurbolonSpray electrospray ionization (ESI) come fonte e UPLC System 1290 Series (Agilent).



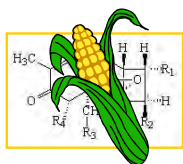
(Vishwanath et al., 2009; Malachova et al., 2014)

Maize – Indagine su post-raccolta (lotti)



	Micotossina ($\mu\text{g kg}^{-1}$)	2012	2013	2014	2015	Lotti positivi
Fusarium sect. Liseola	Fumonisine	8997	6151	15040	9456	100
	Acid fusarico	356	1236	492	230	96
	Bikaverina	294	853	175	102	100
	Beauvericina	187	195	135	101	100
	Moniliformina	852	344	505	574	100
	Fusaproliferina	959	1551	1346	875	94
	Equisetina	40	55	59	15	90
Fusarium Discolor	DON	419	2923	3007	257	77
	DON-3-G	138	595	1247	89	89
	Culmorina	197	2621	970	94	79
	Zearalenone	26	367	490	24	85
	Butenolide	60	410	592	117	85
	Aurofusarina	194	4099	9642	239	85
Altri Fusaria	T2 + HT2	nd	nd	14	15	17
	Enniatine	nd	2	43	3	16
Aspergillus	Aflatossine	40	14	1	5	53
	Acido secalonico	126	101	137	158	56
Alternaria	TENT, AHO, AME	4	2	6	4	40

North Italy 2012 – 2015, 50 samples for each growing season



Indagine su post-raccolta (lotti)

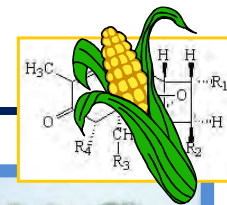
Contaminazione secondo la regione di provenienza



Micotossina	Regione	2014	2015
FBs	Piemonte	8916	7537
	Lombardia	15206	11139
	Veneto	20518	7952
	Friuli Venezia Giulia	9452	19273
	Emilia-Romagna	21592	7907
FA	Piemonte	430	193
	Lombardia	626	206
	Veneto	438	161
	Friuli Venezia Giulia	382	366
	Emilia-Romagna	473	180
BIK	Piemonte	135	87
	Lombardia	167	104
	Veneto	184	75
	Friuli Venezia Giulia	133	250
	Emilia-Romagna	277	95
BEA	Piemonte	184	163
	Lombardia	128	91
	Veneto	108	33
	Friuli Venezia Giulia	71	101
	Emilia-Romagna	121	95
MON	Piemonte	576	619
	Lombardia	529	748
	Veneto	395	383
	Friuli Venezia Giulia	324	615
	Emilia-Romagna	579	469
FUS	Piemonte	1202	833
	Lombardia	2316	918
	Veneto	727	325
	Friuli Venezia Giulia	1084	774
	Emilia-Romagna	947	559
EQUI	Piemonte	17	19
	Lombardia	108	16
	Veneto	105	15
	Friuli Venezia Giulia	15	1
	Emilia-Romagna	16	10
DON	Piemonte	4035	320
	Lombardia	3085	81
	Veneto	3299	40
	Friuli Venezia Giulia	3265	43
	Emilia-Romagna	255	46
DON-3G	Piemonte	1678	132
	Lombardia	1276	22
	Veneto	1401	20
	Friuli Venezia Giulia	1313	23
	Emilia-Romagna	73	14
15-ADON	Piemonte	645	59
	Lombardia	489	0
	Veneto	382	6
	Friuli Venezia Giulia	470	0
	Emilia-Romagna	45	7

Micotossina	Regione	2014	2015
NIV	Piemonte	28	2
	Lombardia	44	0
	Veneto	56	0
	Friuli Venezia Giulia	42	6
	Emilia-Romagna	94	22
CULM	Piemonte	1637	143
	Lombardia	959	19
	Veneto	738	20
	Friuli Venezia Giulia	758	12
	Emilia-Romagna	106	20
ZEA	Piemonte	686	26
	Lombardia	456	3
	Veneto	590	5
	Friuli Venezia Giulia	465	7
	Emilia-Romagna	11	56
BUT	Piemonte	756	169
	Lombardia	754	82
	Veneto	512	48
	Friuli Venezia Giulia	648	30
	Emilia-Romagna	94	26
AU	Piemonte	13080	446
	Lombardia	11456	35
	Veneto	7750	51
	Friuli Venezia Giulia	12701	112
	Emilia-Romagna	1127	112
T2-HT2	Piemonte	4	11
	Lombardia	12	2
	Veneto	5	0
	Friuli Venezia Giulia	1	0
	Emilia-Romagna	0	0
Enns	Piemonte	0	1
	Lombardia	0	0
	Veneto	0	0
	Friuli Venezia Giulia	10	0
	Emilia-Romagna	49	0
Afla_tot	Piemonte	0	2
	Lombardia	0	5
	Veneto	0	4
	Friuli Venezia Giulia	0	2
	Emilia-Romagna	0	1
SED	Piemonte	14	153
	Lombardia	112	161
	Veneto	0	21
	Friuli Venezia Giulia	8	95
	Emilia-Romagna	8	64
ALTERNARIA	Piemonte	1	1
	Lombardia	7	4
	Veneto	1	3
	Friuli Venezia Giulia	3	6
	Emilia-Romagna	2	1

Mais – Lavorazioni del terreno



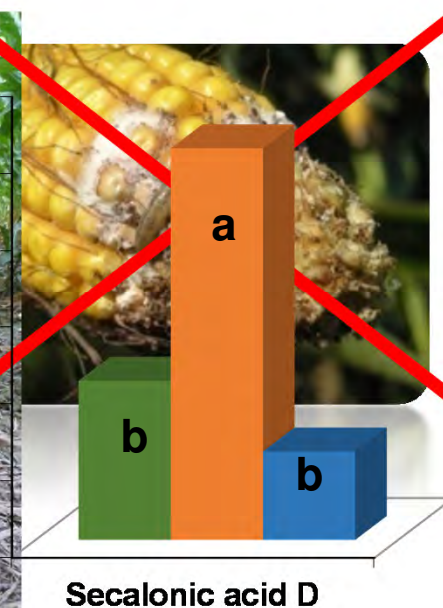
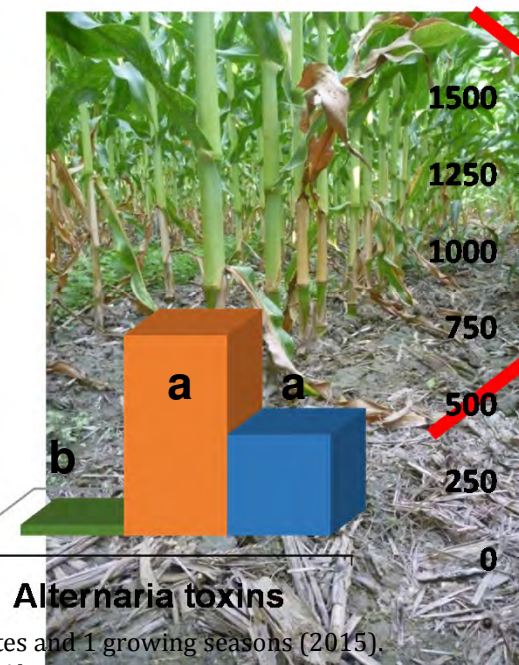
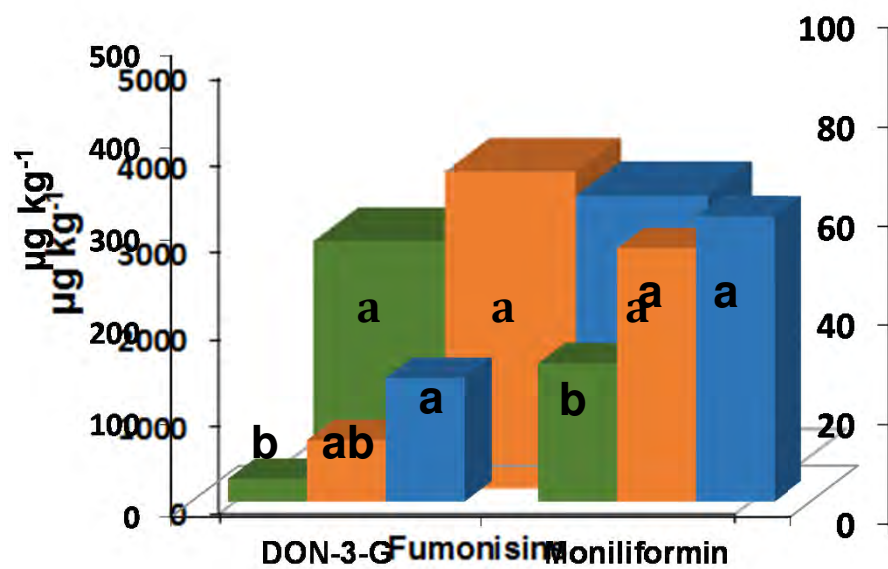
Aratura



Minima lavorazione

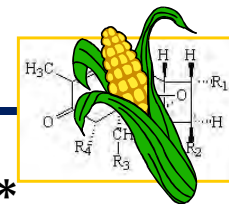


Strip tillage



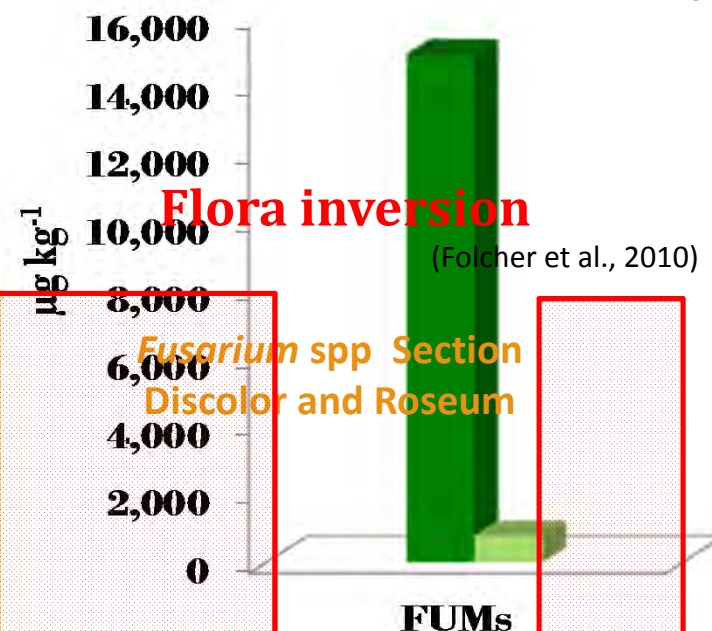
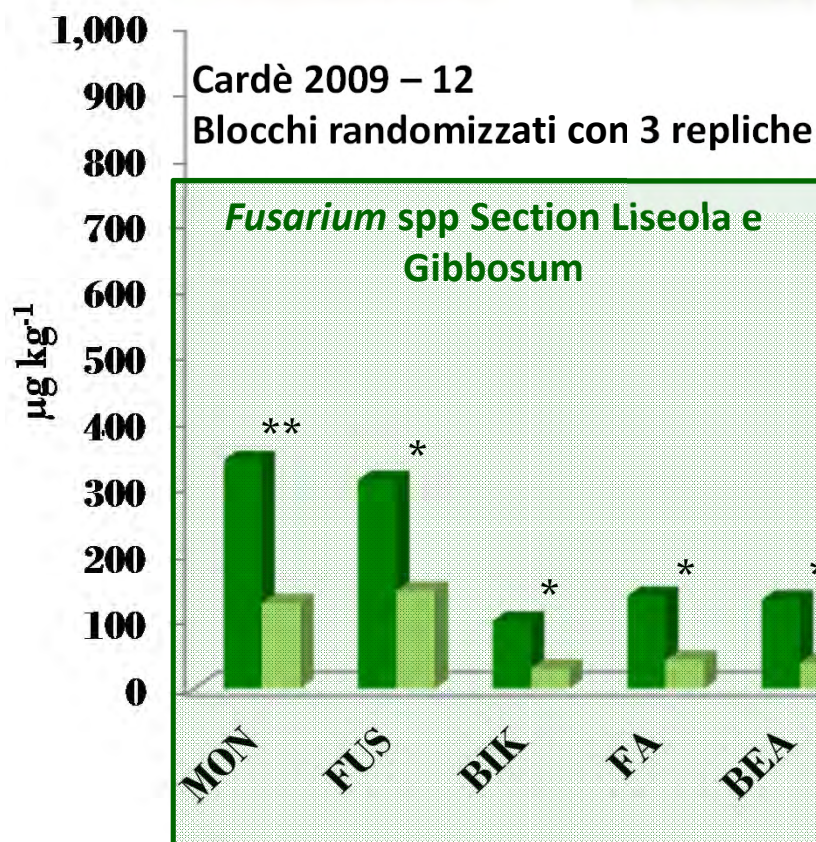
Different letters means significant differences for $P < 0.05$ – Average data of 2 sites and 1 growing seasons (2015).
 Alternaria toxins = sum of Tenuazonic acid, Alternariol, Alternariolmethylether, Altersetin.

Mais – Applicazione di insetticidi



■ Non trattato ■

■ Insetticida ■



P(F) = Level of significant of ANOVA * P < 0.05, ** P < 0.01

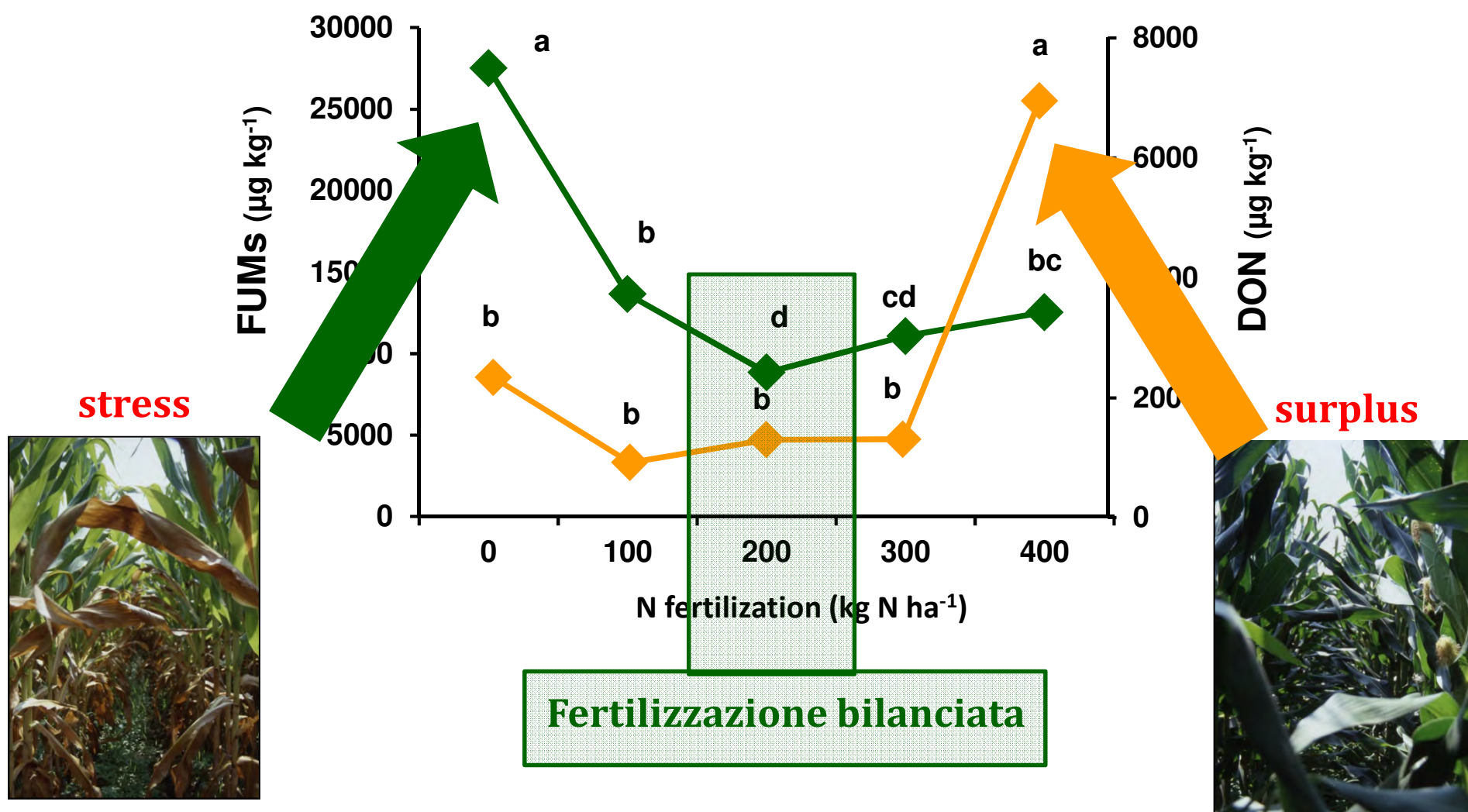
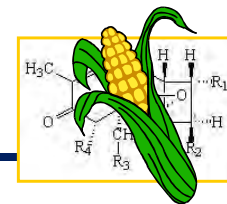
FUMs = Fumonisin; MON = Moniliformin; FUS = Fusaproliferin; BIK = Bikaverin; FA = Fusaric Acid; BEA = Beauvericin; EQU = Equisetin; AUR = Aurofusarin; DON = Deoxynivalenol; DON-3-G = Deoxynivalenol-3-Glucoside; ZEA = Zearalenone; CULM = Culmorin; BUT = Butenolide

3 ibridi (FAO 500-600)

AU



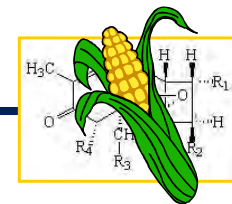
Mais – fertilizzazione azotata



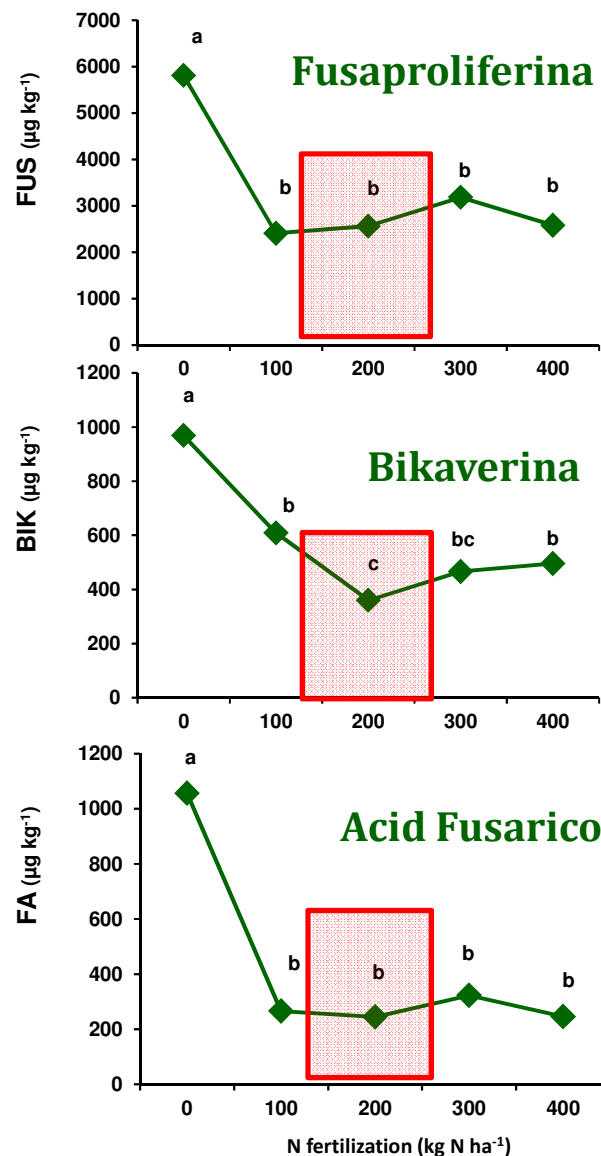
Lettere diverse indicano differenze significative per $P < 0.05$ – Media 2012 e 2013.

FUMs = Fumonisin; MON = Moniliformin; FUS = Fusaproliferin; BIK = Bikaverin; FA = Fusaric Acid; BEA = Beauvericin; EQU = Equisetin; AUR = Aurofusarin; DON = Deoxynivalenol; DON-3-G = Deoxynivalenol-3-Glucoside; ZEA = Zearalenone; CULM = Culmorin; BUT = Butenolide

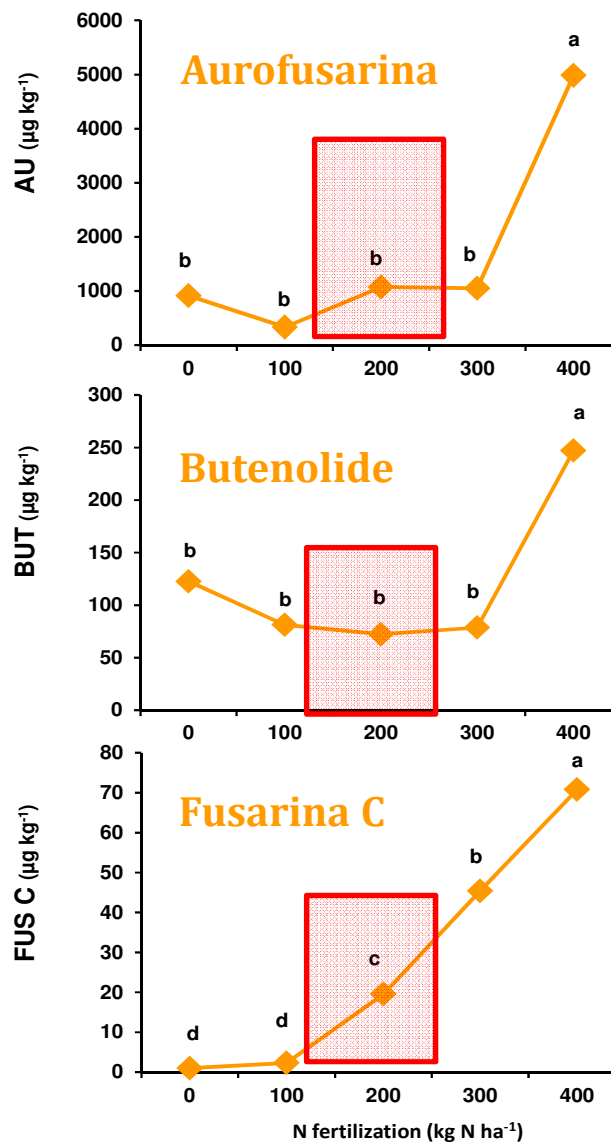
Mais – fertilizzazione azotata



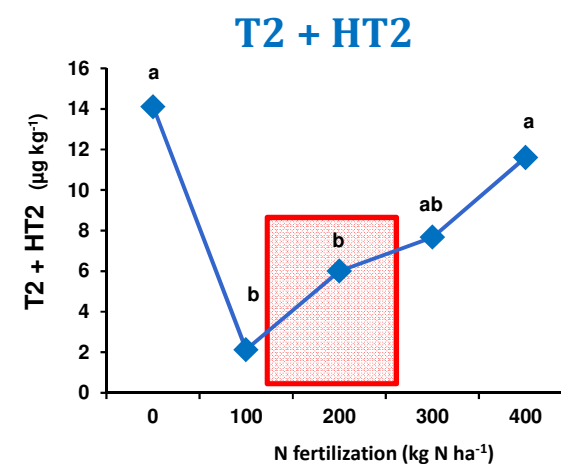
Sezione Liseola



Sezione Discolor e Roseum



Sezione Sporotrichiella

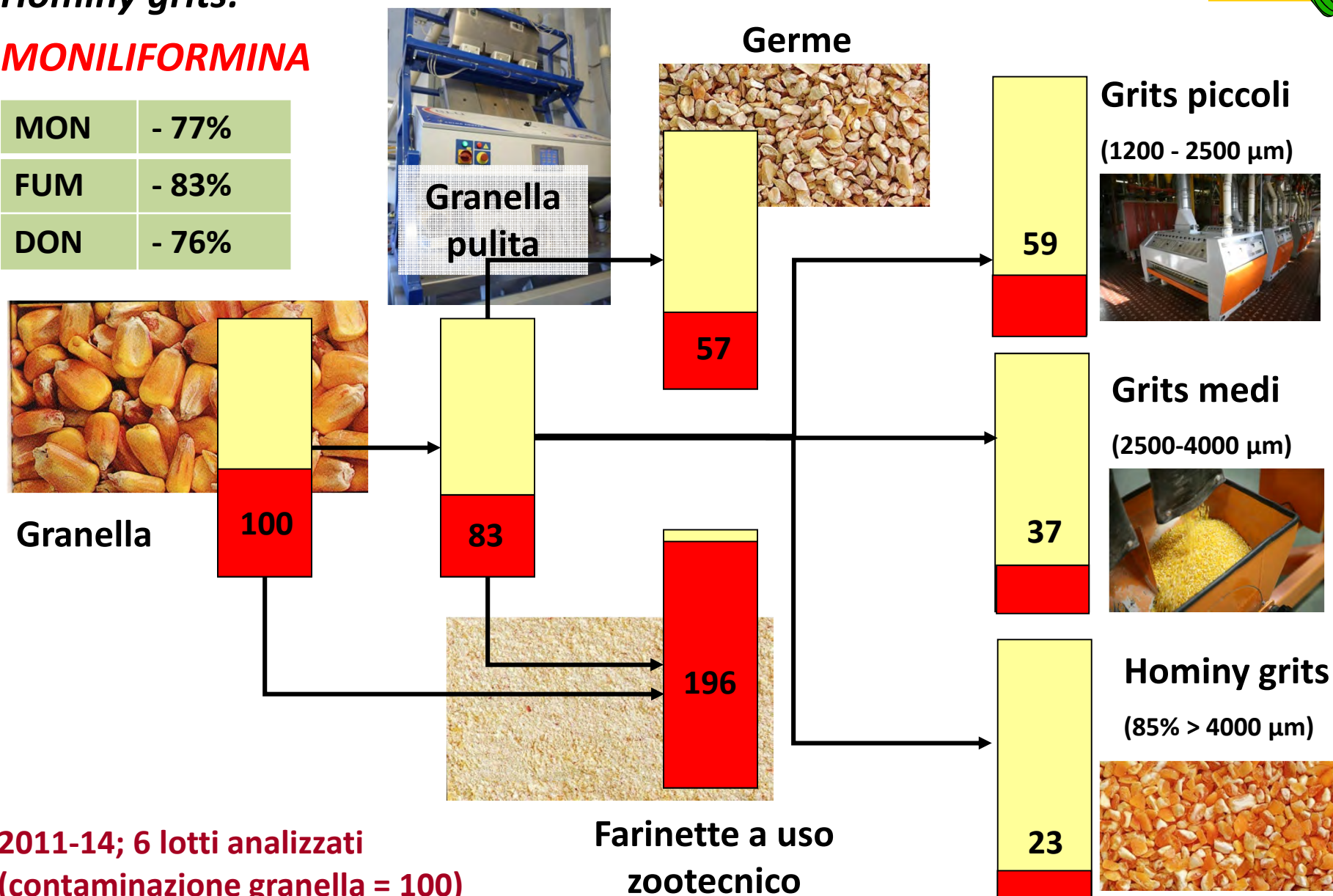


Means followed by different letters are significantly different for $P < 0.05$ – Average data of 2012 and 2013 growing seasons.

A chemical structure of a substituted cyclohexane ring is shown, with a corn cob illustration overlaid. The ring has substituents H_3C , O , R_4 , CH , R_3 , and R_2 . The CH group is part of a chain that includes H , O , and R_1 groups.

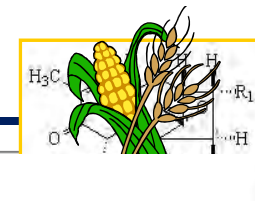
MONILIFORMINA

MON	- 77%
FUM	- 83%
DON	- 76%

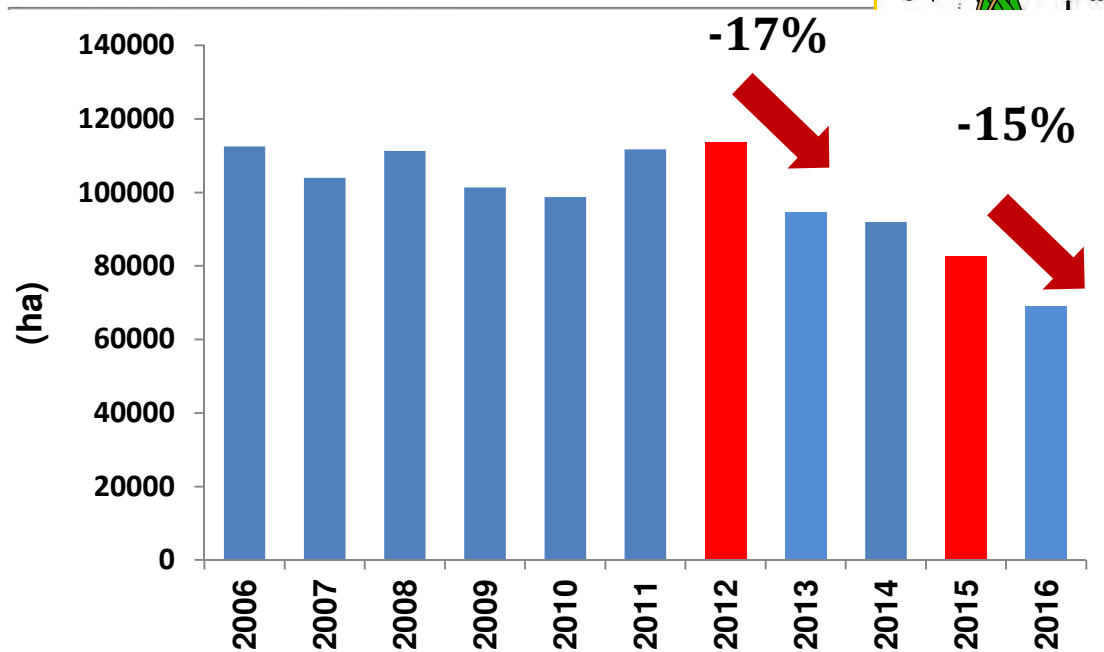


**2011-14; 6 lotti analizzati
(contaminazione granella = 100)**

Effetto delle micotossine sul mercato del mais



Evoluzione della superficie
Maidicola in
Emilia – Romagna (ha)



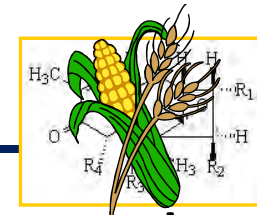
Borsa di Milano – Sept. 10, 2016

Mais granella	Sept.'15	Sept.'16
Alimentare	117	112
Naz. zootecnico con caratteristiche	109	107
Nazionale	100	100
Comunitario	116	111
Non comunitario	123	114
Bioenergetico		-

Controllo sanitario e
qualitativo

Adeguate controllo
Sanitario (micotos.)

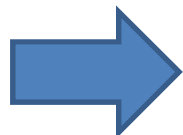
Conclusioni e prospettive



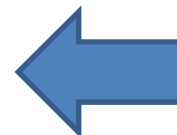
- Presenza di **micotossine nuove o emergenti nei cereali** in aree temperate :



Tossine da *Alternaria*
Alcaloidi dell'Ergot



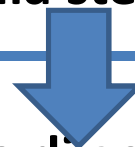
Altre
***Fusarium* tossine**



Aflatossine

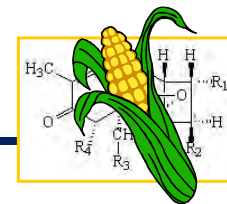


- Le condizioni agro-ecologiche per l'accumulo di tossine "nuove" ed "emergenti" si sovrappone a quello già individuato per le tossine principali prodotte da *Fusaria* della stessa sezione

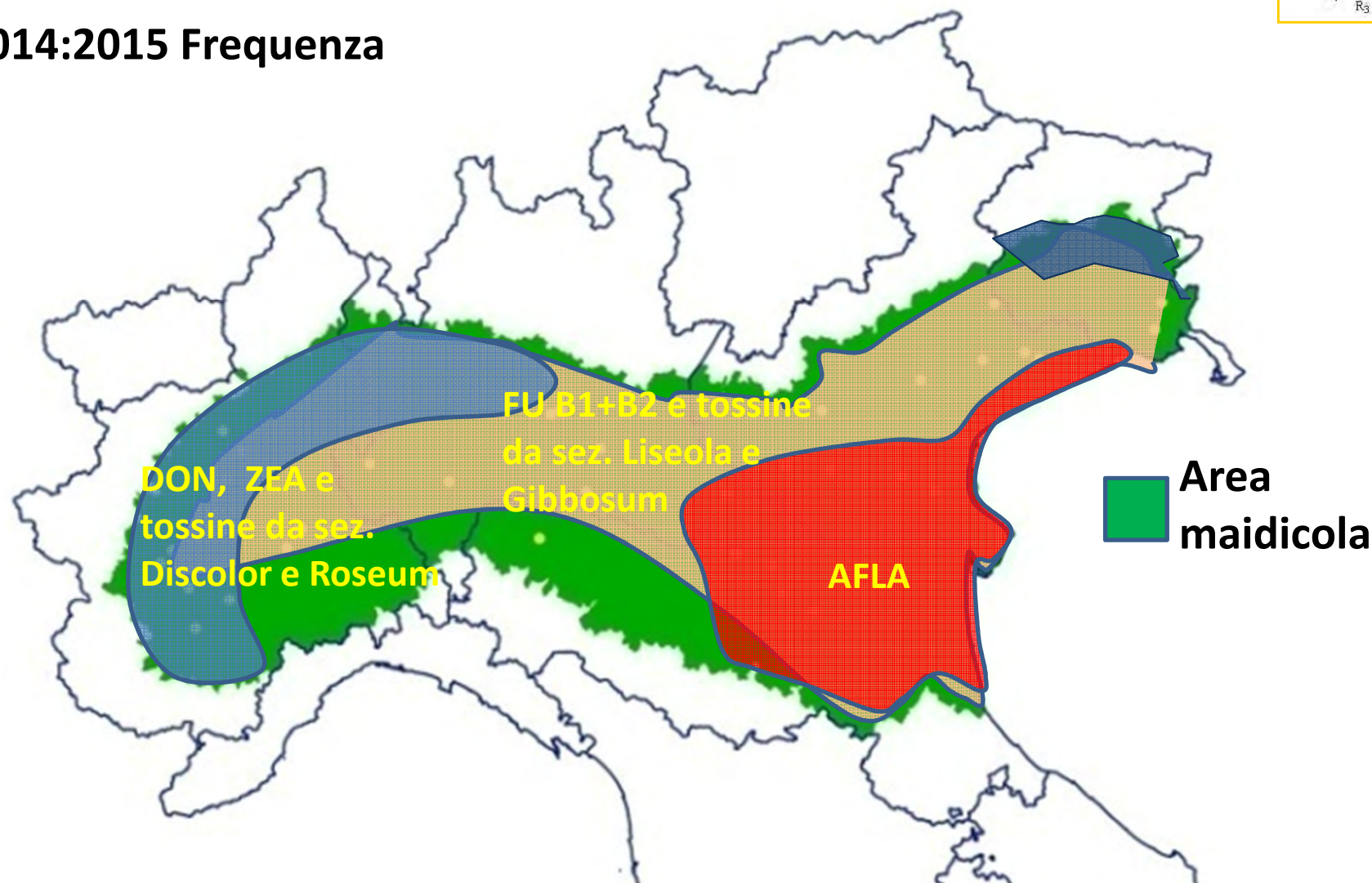


- Le buone pratiche agricole (GAP) e di gestione (GMP) già proposte per le tossine principali possono quindi essere estese a quelle "nuove" ed "emergenti" prodotte dai *Fusaria* della stessa sezione

Conclusioni e prospettive



2014:2015 Frequenza





Linee guida (LG)

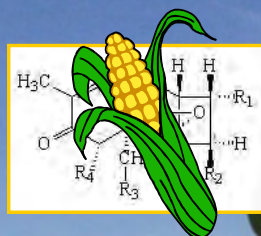


LINEE GUIDA PER IL CONTROLLO DELLE MICOTOSSINE PRINCIPALI ED EMERGENTI NELLA GRANELLA DI MAIS E DI FRUMENTO





**Amedeo Reyneri, Massimo Blandino,
Valentina Scarpino**



Grazie