EUROPEAN PARLIAMENT
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Redefining Integrated Pest Management

(Is it necessary?)

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IPM ACCORDING TO DIRECTIVE 2009/128/EC

1. Before any decision on pest control is taken, harmful organisms must be monitored with adequate methods and tools, where available; tools should include observations in the field as well as scientifically sound warning, forecasting and early diagnosis systems.

2. Crops may only be treated when and where the assessment has found that levels exceed set economic thresholds.

3. When economic thresholds are exceeded, agronomic solutions, mainly rotation, should be considered to prevent crop damage, as tillage timing, choice and changing of sowing dates, and crop rotation interfere with newly established pest populations.

IPM ACCORDING TO DIRECTIVE 2009/128/EC

4. When economic thresholds are exceeded and no agronomic solutions are available, biological control, physical treatment or another non-chemical pest control method should be considered as a replacement for chemical treatment.

5. When economic thresholds are exceeded and no agronomic solutions, biological controls, physical treatments or other non-chemical pest control methods are available, chemical treatments should be selected from options that pose the lowest risk to the environment and human health. It should be used so that the risk of pest resistance is minimised

WHAT INTEGRATED PRODUCTION (IP) IS?

Integrated Production

A complex of adequate farming practices including the optimal use of natural resources, the protection and augmentation of natural antagonists of pest organisms, the elimination of farm operations with negative impact on the agroecosystem. Rotation, multi-component landscape, soil health and suitable fertilization (e.g. no excessive fertilizer use and organic matter preservation), tillage practices ensuring good soil structure, etc. are key parts of the complex of adequate farming practices

WHAT IP IS?

Integrated Production

IP not only allows the production of healthy food but becomes a complex of preventive measures on the farm that reduces the need of pest control, due to:

1) higher tolerance of plants to harmful organism (good plant health);
2) a lower general pressure of pests because of an higher presence of pest antagonists.

IP AND IPM – IPM AND IP

INTEGRATED PEST MANAGEMENT directly concerns harmful organisms and may give the maximum benefits in the framework of IP and IP tools may be also IPM strategies

IPM exclude the prophylactic use of chemicals (while the prophylactic sustainable exploitation of natural resources through adequate farming practices of IP is a positive factor)

Monitoring and forecasting systems are the base to decide if a pest control is needed providing the necessary instruments for the decision (if and when direct plant protection has to be applied)

IP AND IPM – IPM AND IP

However, the use of non-chemical control options has priority and pesticides are used only as the last resort if other methods do not produce acceptable results

The Integrated approach means trying to get the best protection results also integrating all the sustainable tools/tactics taking into the consideration all the interactions between the harmful organisms, between harmful organisms and beneficials, between control tools, between control tools and harmful organisms and beneficials, etc.

IP AND IPM – IPM AND IP

IN OTHER WORDS

IP REDUCES THE PROBABILITY THAT IPM PROCEDURE FINDS HARMFUL ORGANISM POPULATIONS EXCEEDING THE DAMAGE THRESHOLDS AND CAN BECOME PART OF THE IPM STRATEGY

CAN IPM BE USED?

For each combination crop/agronomic-climatic conditions we need to answer the following questions:

1. What is the risk level? Do population levels exceed thresholds everywhere? Is treatment needed in all fields, or just some?

2. Are IPM strategies available (e.g. monitoring methods, risk assessment, key-pest thresholds, agronomic and/or biological alternatives)?

AN IMPORTANT CASE STUDY:
ARABLE CROPS/MAIZE

WHAT IS IPM IN ARABLE CROPS (MAIZE)?

1. Implementation of sampling/models/thresholds: control methods only used when the pest population exceeds the threshold.

1. When the pest population exceeds the threshold, the first option is to implement agronomic solutions, e.g. resistant/tolerant hybrids, cultivation strategies (change sowing date, irrigation, growth stimulants).

2. When the pest population exceeds the threshold and no agronomic solution is available, the second option is to implement biological or any other non-chemical tools.

WHAT IS IPM IN ARABLE CROPS (MAIZE)?

4. When the pest population exceeds thresholds and no biological/non-chemical options are available, chemical treatments should be selected from options that pose the lowest risk to the environment and human health. They should be used so that the risk of pest resistance is minimised, i.e. limit use over area and time.

5. Before chemical treatments are used, assess the optimum time to apply them (multi-task treatments – timing that may allow the control of more than one pest); pesticide use according anti-resistance strategies ,

IPM ACCORDING TO DIRECTIVE 128/2009/EC ON ARABLE CROPS: A TOUGH CASE

Although most pesticides worldwide are applied to control arable-crop parasites

IPM IS NOT USED EXTENSIVELY ON ARABLE CROPS
(but is widely implemented on other crops, e.g. orchards).

Therefore:

- ARABLE CROPS (e.g. maize) make it tougher to implement Directive 2009/128/EC properly.
- A SPECIAL EFFORT is needed to make the directive work for arable crops.

IPM OF ARABLE CROPS

A REVOLUTION

IPM OF ARABLE CROPS

- Low-income crops;
- Little manpower available;
- General low technical knowledge;
- Little tradition/experience of monitoring and IPM, unlike in orchards/vineyards.

REQUIREMENTS

- Low-cost strategies;
- Time-saving tools;
- Sustainable technical tools.

REQUIREMENTS

Do we have the knowledge to implement IPM of arable crops?

REQUIREMENTS

- Area-wide observations (low cost/ha);
- Complementary limited in-field evaluation, where needed.

REQUIREMENTS AT AREA-WIDE LEVEL

- Mainly semio-chemical based tools;
- Statistical evaluation methods (e.g. Geostatistics);
- Meteorological information / forecasting models;
- Agronomic information.

BASIC STRATEGIES

- Real-time dissemination of area-wide and model information by email/text;

- Technician training.

MAIN MODELS

- **WEED IPM**: ALERTINF EMERGENCE PATTERNS OF THE MAIN WEEDS (PADUA UNIVERSITY);
- **WCR IPM:** WCR EGG AND LARVAL DEVELOPMENT (DAVIS);
- **WCR IPM:** ADULT/FEMALE DEVELOPMENT PATTERNS (NOWATZKY);
- **BLACK CUTWORM ALERT PROGRAMME:** IOWA UNIVERSITY (ADAPTED TO ITALY);
- **ECB:** POPULATION DEVELOPMENT;
- **CROPS:** CROP DEVELOPMENT PATTERNS (CROPSYST);
- **FUSARIUM CEREALS**: DISEASE PATTERNS (BEING DEVELOPED);

DISSEMINATION OF IPM

MAIN BULLETIN CONTENT

- Flexibility: published on average at least weekly, but varies with requirements, as closely related to crop and pest development. Information forwarded by email and available online (www.venetoagricoltura.org). Alerts also given by SMS for immediate risks;

- Advanced planning: continuous information on how to react promptly and properly in case of alert messages;

- Training: bulletins designed to provide in-depth information (e.g. recognition of symptoms, pests);

- Participation: farmers can use monitoring tools;

- Interaction: chance to ask questions and to propose changes.

CAN IPM BE USED ON MAIZE?

1. What is the risk level? Do population levels exceed thresholds everywhere? Is treatment needed in all fields, or just some?

2. Are IPM strategies available (e.g. monitoring methods, risk assessment, key-pest thresholds, agronomic and/or biological alternatives)?

PESTICIDES AND HARMFUL ORGANISMS

- Soil insecticides (e.g. wireworms, WCR);
- Herbicides;
- Post-emergence insecticides (e.g. to fight black ECB);
- Fungicides (e.g. seedling diseases, *Fusarium*).

PESTICIDES AND HARMFUL ORGANISMS

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PESTS AT EARLY STAGES

VIRUSES TRANSMITTED BY INSECTS

Neonics effective, but diseases have low incidence; hybrids are usually resistant. Resistant hybrids are as effective as neonicotinoids.
Furlan L, Chiarini F, Balconi C, Lanzanova C, Torri A., Valoti P, Alma A, Saladini MA, Mori N, Davanzo M, Colauzzi M (2012) *Possibilità di applicazione della difesa integrata per il controllo delle virosi nella coltura del mais, Apoidea*, 1-2, 39 – 44.

OTHER ANIMALS

Other solutions

INSECTS AND OTHER ARTHROPODS

PESTS AT EARLY STAGES: insects and other arthropods

- Black cutworms (BCW);
- Diabrotica (WCR);
- Wireworms (WIR);
- Other soil pests, e.g. Diplopods (generally low incidence).

BLACK CUTWORMS

BLACK CUTWORMS (*A. ipsilon*)

- Occasional attacks (last major outbreaks 1971 and 1983);
- Low economic damage;
- Attacks not predictable at sowing;
- Negligible control by soil insecticides when needed (including seed coating);
- Alert programme predicts when and where post-emergence treatments are needed.

TREATMENT UNJUSTIFIED AT SOWING

BLACK CUTWORMS

Traditional (non-IPM) approach

- Soil insecti[illegible]es - n[illegible]pecific evaluation of p[illegible]resence;
- You have to t[illegible]m; you never know!

IPM OF BLACK CUTWORMS

AREA-WIDE LEVEL

- Black cutworm alert programme: moth arrival predicted with pheromone traps (southern winds assessed, formation of harmful instars assessed with a development model);

- Bulletin on population development;
- Possible foliar treatment when fourth instar forms, and scouts forecast an early attack above threshold (5% of plants damaged).

TREATMENT UNJUSTIFIED AT SOWING

IPM OF BLACK CUTWORMS

COMPLEMENTARY LIMITED IN-FIELD EVALUATION

- Scouts sent to monitor at field level only where area-wide monitoring detected moth populations;
- When harmful stage forms (fourth instar, DD accumulation) in an identified area, scouts sent to look for damaged plants;
- Post-emergence treatment implemented when an early above threshold attack occurs (5% of plants damaged);
- Effective insecticides available.

IPM OF BLACK CUTWORMS

YEAR	FIRST CAPTURE	FIRST SIGNIFICANT FLIGHT	FLIGHT LEVEL	southern wind	4th INSTAR first larvae	peak of 4th instar larvae	Forecast date for 176 DD	DAMAGE LEVEL
1991	March 6	March 21-26	Medium	not available data	NO larvae found			very low
1992	April 1	April 3-6	low	17 - 22/3; 29/3-2/4	NO larvae found			NO DAMAGE
1993	March 29	April 6	low	13-20/3; 29/3-1/4	NO larvae found			NO DAMAGE
1994	March 4	Marchy 23 - 26	medium	2/3; 22 - 24/3	May 5	May 7-8	May 8-13	medium
1995	March 11	NO	very low	7/3; 27-28/3	NO larvae found			NO DAMAGE
1996	March 18	April 3	medium	5/3; 31/3	May 2	May 6-8	May 9-11	medium
1997	NO	NO	very low	20-22/3; 26-27/3; 30-31/3	NO larvae found			NO DAMAGE
1998	March 16	April 5-12	medium	13-18/3; 28/3-4/4	May 13	May 15-17	May 8-13	medium
1999	March 26	April 6	low	23-25/5; 3-4/4	May 10	May 14	May 5-10	low
2000	March 29	March 29 April 5	medium	20-23/3; 29-31/3	May 4	May 8	May 4-8	low
2001	March 2	March 17	medium	27/2; 15/3	April 29	May 1-2	May 5-9	medium

Table: results of the implementation of the Black Cutworm Alert programme in Veneto over a 11 years.

BLACK CUTWORMS: CAN IPM BE IMPLEMENTED?

1. What is the risk level? Low, < 1%

2. Are IPM strategies available (e.g. monitoring methods, risk assessment, key-pest thresholds, agronomic [and/or biological alternatives)? Yes, black cutworm alert programme producing accurate results in Italy since 1991.

BLACK CUTWORMS: ACCORDING TO DIRECTIVE 2009/128/EC

1. Treatment may be applied only once pest population levels have been estimated with monitoring and development models: Available

2. Treatment may then be carried out only when and where monitoring has found that levels are above set economic thresholds: Available

3. When economic thresholds are exceeded, agronomic solutions, mainly rotation, should be considered to prevent damage to maize crops: Not available in practice

4. When economic thresholds are exceeded and no agronomic solutions are available, biological control, or any other non-chemical pest control method, should be considered as a replacement for chemical treatment: Not available in practice

BCW: BULLETIN CONTENT

- General pest information;
- Area-wide monitoring information – area hit by damaging population;
- Egg-laying period – fields at risk during flying period;
- Development model – formation of the fourth instar;
- Trial results.

WCR

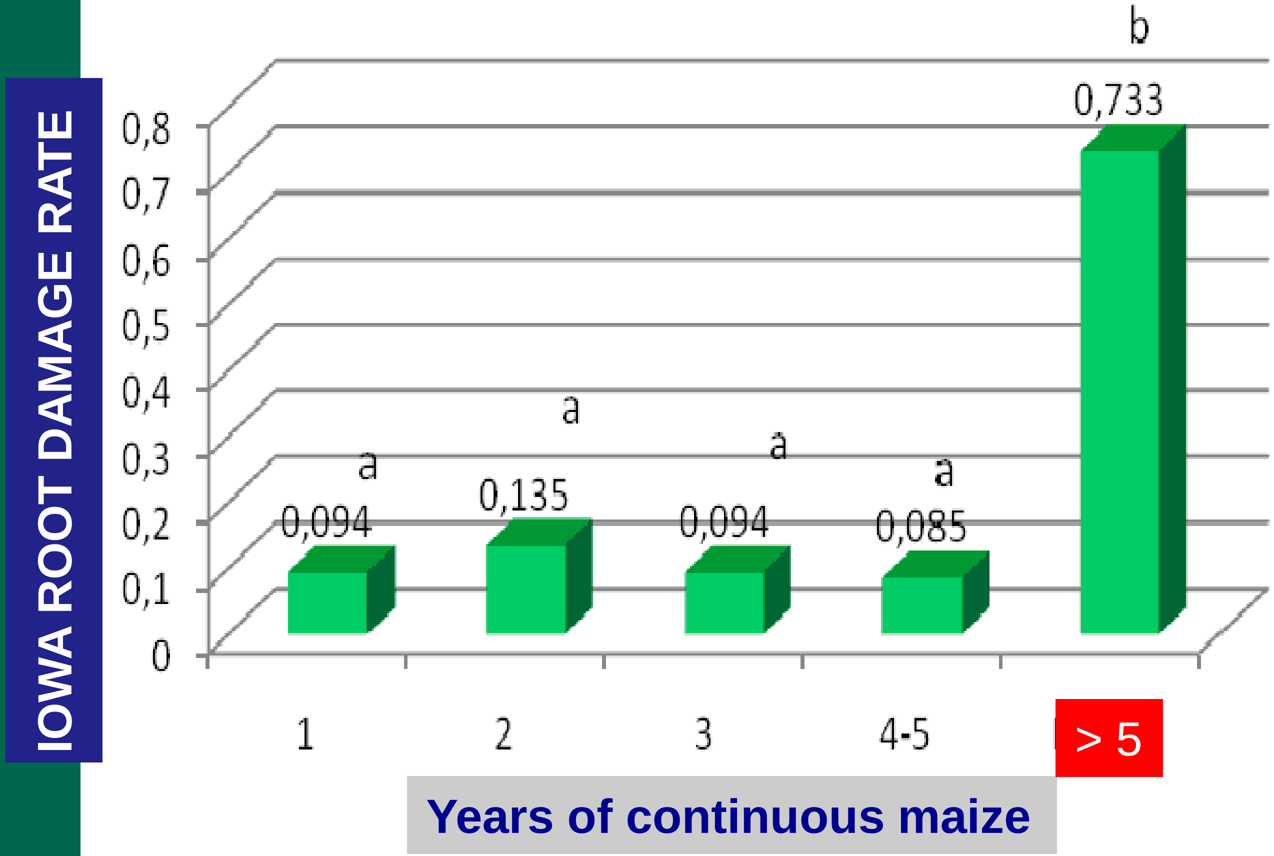
IPM OF WCR

- Populations below economic threshold in most European maize fields;
- Rotation: the only fully effective strategy (see Directive 128/2009/EC);
- Rotation may be effective even as a ‘soft’ method (every two or more years if implemented on a large scale);
- Some rotation solutions do not reduce the gross margin of livestock/biogas farms;
- Treatment at sowing does not significantly affect WCR population dynamics;
- Insecticide may fail.

TREATMENT UNJUSTIFIED AT SOWING

THRESHOLD 6 beetles/trap/day over a 3 – 6 week period

WCR - DIABROTICA



Assessments 2012-2013 in areas with high WCR populations
(Vicenza and Treviso provinces in Veneto, north-east Italy)
1 = maize sown straight after interruption
2 = second year of maize after interruption, and so on

WCR – DIABROTICA: CAN IPM BE IMPLEMENTED?

1. What is the risk level? Low

2. Are IPM strategies available (e.g. monitoring methods, risk assessment, key-pest thresholds, agronomic [rotation] and/or biological alternatives)? WCR can be kept below economic thresholds by rotation, the most effective IPM type according to Directive 2009/128/EC – Annex III: IPM of Diabrotica involves implementing rational rotation without chemical treatment (at sowing, or later, against beetles).

WCR – DIABROTICA: IPM ACCORDING TO DIRECTIVE 2009/128/EC

1. Treatment may be applied only once pest population levels have been estimated with monitoring and development models: Available.

2. Treatment may then be carried out only when and where monitoring has found that levels are above set economic thresholds: Available.

3. When economic thresholds are exceeded, agronomic solutions, mainly rotation (the only fully effective, low-impact strategy), should be considered to avoid damage to maize crops: Available.

4. When economic thresholds are exceeded and no agronomic solutions are available, biological control or any other non-chemical pest control method, should be considered as a replacement for chemical treatment: Available (entomopathogenic nematodes).

WCR: BULLETIN CONTENT

- General pest information;
- Area-wide monitoring information;
- Monitoring-based population level;
- Geostatistic assessment;
- Davis development model - completion of egg hatching for area;
- Date for sowing without any WCR development;
- Appearance of gravid females (for possible treatment against the adults);
- Interaction with ECB (period when an insecticide can control WCR and ECB at the same time);
- Trial results.

WIREWORMS

WHAT IS IPM AGAINST WIR?

IMPLEMENTATION
OF SAMPLING/MODELS/THRESHOLDS:
treatments only after pest assessment.

WIREWORMS

A CASE STUDY OF ITALY

FIELDS DAMAGED BY WIREWORMS (over 30 years of observations in Italy)

visible damage (plants with attack symptoms common): < 5.0%

high damage (> 30% of plants damaged): < 1.0

WIREWORMS
(Apenet 2010 – a major survey in the Po Valley)

ITALIAN REGIONS	MONITORED FIELDS	WITH RISK FACTORS (*A.brevis, A.sordidus*)	WITH RISK FACTORS (*A.litigiosus, A.ustulatus*)	*A. brevis mean (e.s., min-max)*	*A. sordidus mean (e.s., min-max)*	*A. litigiosus mean(e.s., min-max)*	*A. ustulatus mean (e.s., min-max)*	PLANT STAND pp/m^2 HEALTHY *(mean, min, max)*	media (pp sane % of heakthy plants out of total sown seeds)	Plants damaged by wireworms % of emerged plants (mean, min, max)	Fields with visible damage on plants – no economic damage (up to 10% of damged plants) (n°)	Fields with economic damage
VENETO	51	6	6	76 (18.3, 0.0- 691)	523 (53.1, 91-2129)	n.r.	548 (88,4, 0,00-2786,00)	6,46 (0.07, 5.30-7.38)	90.3	1.14 (0.024, 0.0- 7.0)	2	0
EMILIA ROMAGNA	105	7	4	n.r.	245 (26.44, 4.00-2201)	253 (24.3, 6.0-1141)	n.r.	n.r.	n.r.	n.r.	1	0
LOMBARDY	10	2	1	n.r.	983 (244, 189 - 2349)	629 (202, 63-2087)	n.r.	6.48 (0.06, 4.80 – 7.3)	93.2	0.17 (0.071, 0.10-0.81)	1	0
PIEDMONT	6	1	0	n.r.	1091 (290, 123-2311)	243 (52, 46-549)	n.r.	7.00 (0.12, 6.40-7.40)	94.6	5.8 (0.017, 0-12)	1	0
FRIULI	11	2	0	169 (19.7, 86 - 323)	335 (66.6, 59-763)	12 (6.41, 0.00-52.0)	n.r.	6.63 (0.05, 6.35 – 6.90)	90.7	0.059 (0.01, 0.05-0.1)	0	0
TOTAL	183	18	11								5	0
(%)											2.7	0

PURE PROJECT (7TH FRAMEWORK PROGRAMME) 2011 - 2012

- Three on-station experiments - France, Hungary and Italy (long-term) to investigate different IPM strategies.
- Fifteen on-farm experiments (France, Germany, Hungary, Italy and Slovenia).

WIREWORMS

WHAT ABOUT OTHER MEMBER STATES?

Fifteen on-farm experiments were conducted with commercially available equipment in:

- **a Southern European climate (five sites in Italy and two in France);**
- **a Central European climate (two sites in Germany);**
- **an Eastern European climate (four sites in Hungary and two in Slovenia).**

Thirty-one experiments in two years on untreated fields/plots, or on alternate treated/untreated strips found

NO ECONOMIC WIREWORM DAMAGE

CURRENT IPM TOOLS

- Risk factors
- Pheromone traps
- Bait traps
- Agronomic strategies
- Biocidal plants and meal
- Other biological treatments

CROPS PLANTED WHEN AND WHERE THERE IS NO SERIOUS RISK OF ECONOMIC DAMAGE

AREA-WIDE LEVEL AGRONOMIC RISK FACTORS

- Continuous plant cover (meadow, double crops, e.g. rye grass/maize, oilseed rape/soybean);
- Peat soils (high organic matter content);
- Previous damage (high beetle captures with Yf and/or high incidence of uncultivated zones, e.g. grasses);
- Irrigation (constant supply of water keeping soil moisture high);

AREA-WIDE LEVEL
YATLORf PHEROMONE TRAPS

- Reliable (non-saturable);
- Few inspections;
- Quick, easy management;
- Low costs;
- Multi-baited (one trap monitors several species at the same time).

BAIT TRAPS FOR COMPLEMENTARY LIMITED IN-FIELD EVALUATION

- Place bait traps when and where there is a risk of economic populations;
- Assess larval thresholds.

wireworm species	wireworm catches (larvae/trap)	sampled fields	fields with yield reduction (maize)	%
Agriotes ustulatus	0-1	64	0	0.0
	1.01-2	7	0	0.0
	2.01-5	9	0	0.0
	5.01-10	**9**	**1**	**11.1**
	>10.01	**5**	**2**	**40.0**
Agriotes brevis	0-1	54	0	0.0
	1.01-2	**6**	**2**	**33.3**
	2.01-5	**7**	**4**	**57.1**
	> 5.01	**3**	**1**	**33.3**
Agriotes sordidus	0-1	113	0	0.0
	1.01-2	10	0	0.0
	> 2.01	**10**	**3**	**30.0**

Furlan, L. (2014) IPM thresholds for *Agriotes* wireworm species in maize in Southern Europe. J Pest Sci, DOI 10.1007/s10340-014-0583-5.

BEFORE THE “BEES AFFAIR”

BALANCED SAMPLE OF MAIZE CONDITIONS IN THE PO VALLEY

- Different soils and crop rotation types;
- Different sowing times;
- Different seed densities and inter-row distances (75 cm - 45 cm);
- Typical cultivation techniques.

SAMPLE CHARACTERISTICS

- Low wireworm population fields: 50%-60%
- Medium wireworm population fields: 40%-20%
- High wireworm population fields: 10%-20%

EXPERIMENT CHARACTERISTICS

- Large plots 300–1500 m^2 (3 m x 4.5 m) in randomized blocks;
- 2–8 replications

Assessments:

- stand at emergence;
- damaged seedlings and plants;
- stand at 4–6 leaves;
- damaged plant stand at 4–8 leaves;
- plants damaged by other pests (e.g. aphids, viruses)
- Yield.

TREATMENTS

1. Naked seeds (untreated): no insecticide or fungicide as seed treatments;
2. Metalaxil+fludioxonil (Celest®), fungicide, 100 ml/q of seed;
3. Imidacloprid (Gaucho®), insecticide, 1.2 mg a.i./seed;
4. Fipronil (Regent® TS), insecticide, 0.6 mg a.i./seed;
5. Thiametoxam (Cruiser®), insecticide, 0.63 or 1.25 mg a.i./seed;
6. Thiametoxam+tefluthrin rate (Powered by Cruiser & Force), both insecticides: thiametoxam 1.00 mg a.i./seed + tefluthrin 0.4 mg a.i./seed;
7. Clothiadinin (Poncho®), insecticide, 1.25 mg a.i./seed.

MORE THAN 60 FIELDS
AND
MORE THAN 1000 PLOTS

2003 – 2006

FURLAN L., CANZI S., TOFFOLETTO R., DI BERNARDO A. (2007) *Effetti sul mais della concia insetticida del seme* (Effects on maize of insecticide seed coating). *L'Informatore Agrario*, 5, 92 -96.

	(Healthy plants/m^2)		Damaged plants		Yield
	emergence	4-6 leaves	pp/mq	%	t/ha (14%)
NAKED SEED	6.26ab	6.33a	0.148a	2.28	12.11a
FUNGICIDE	6.41b	6.58c	0.157a	2.32	12.43a
FUNGICIDE+ CRUISER	6.32ab	6.52bc	0.103a	1.56	12.22a
FUNGICIDE+ REGENT	6.15a	6.38ab	0.087a	1.35	12.31a
FUNGICIDE+ GAUCHO	6.25ab	6.44abc	0.069a	1.01	11.97a

26 fields - 504 plots (Hybrid Tevere)

Means followed by the same letter in a column are not significantly different [?] (Tukey's HSD test, P< 0.05).

2007 – 2008

FURLAN L., CACIAGLI P., CAUSIN R., DI BERNARDO A. (2009) *Il seme di mais va protetto solo quando serve* (Maize seeds should be protected only when needed). *L'Informatore Agrario*, 5, 36 – 44.

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2009

MAIZE CROP RESEARCH UNIT

(CRA-MAC) - Bergamo

	(Healthy plants/m²)		Damaged plants		Yield
	emergence	4-6 leaves	pl/m^2	%	t/ha (14%)
FUNGICIDE	5.63a	6.09ab	0.07bc	1.13	10.90a
FUNGICIDE+PONCHO 1.25	5.55a	6.08ab	0.00a	0.00	10.74a
FUNGICIDE+CRUISER 0.63	5.51a	6.21b	0.02ab	0.32	10.40a
FUNGICIDE+CRUISER 1.25	5.55a	6.13ab	0.01a	0.16	10.73a
FUNGICIDE+CRUISER+FORCE	5.45a	6.07c	0.01a	0.16	10.40a
NAKED SEED	5.36a	5.61a	0.08c	1.41	9.76a

11 fields - 264 plots (Hybrid DKC 6530)

Means followed by the same letter in a column are not significantly different (Tukey's HSD test, $P < 0.05$).

AVERAGE OF 17 TRIALS in 2009 (Hybrid PR31N27)

Active ingredient (trade mark)	Yields (t/ha-15.5% U.R.)	(U.R. %)	PLANT HEIGHT (cm)	EAR HEIGHT (cm)	% BROKEN PLANTS	% LODGED PLANTS
untreated	13.54	22.3	268	119	4.44	0.06
THIAMETHOXAM (CRUISER)	13.24	22.1	269	121	3.80	0.08
IMIDACLOPRID (GAUCHO)	13.37	22.1	267	121	5.25	0.19
CLOTHIANIDIN (Poncho)	13.67	22.1	271	121	5.28	0.06
FIPRONIL (Regent)	13.38	22.3	268	123	4.19	0.06
STATISTICS	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.

Balconi C, Mazzinelli G., Lanzanova C, Torri A., Valoti P, Motto M., Berardo N. (2011) *Mais: secondo anno di sperimentazione agronomica nell'ambito del progetto Apenet, Apoidea*, 1-2, 41 – 45.

2010

MAIZE CROP RESEARCH UNIT

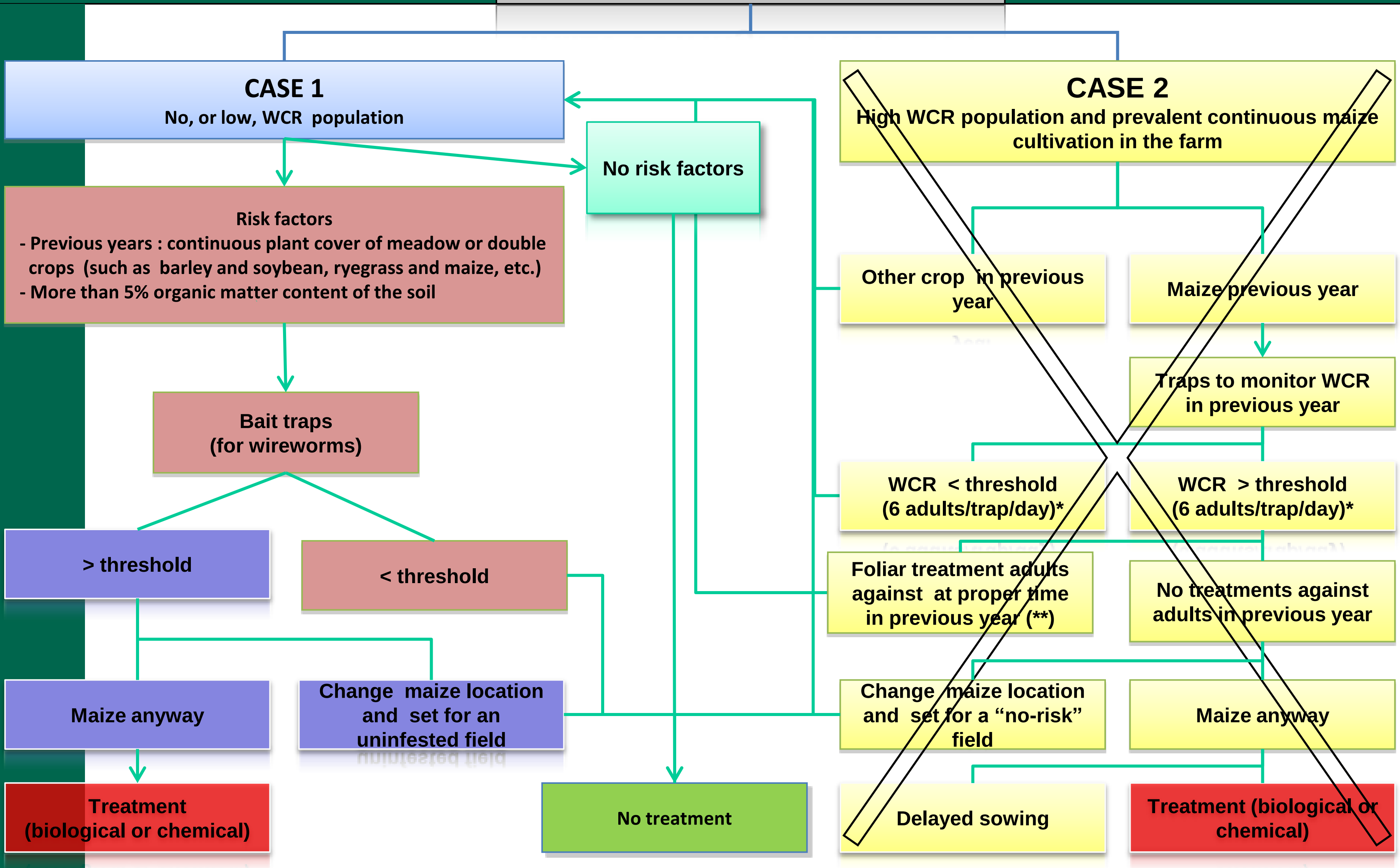
(CRA-MAC) - Bergamo

AVERAGE OF 19 TRIALS in 2010 (Hybrid PR32G44)

Active ingredient (trade mark)	Yields (t/ha-15.5% U.R.)	(U.R. %)	PLANT HEIGHT (cm)	EAR HEIGHT (cm)	% BROKEN PLANTS	% LODGED PLANTS
untreated	13.21	23.59	260.1	129.3	8.11	5.12
THIAMETHOXAM (CRUISER)	13.49	23.50	260.6	129.4	6.83	5.92
IMIDACLOPRID (GAUCHO)	13.46	23.29	262.2	129.6	7.78	4.14
CLOTHIANIDIN (Poncho)	13.82	23.28	264.7	131.7	7.05	5.03
FIPRONIL (Regent)	13.60	23.48	262.7	131.9	8.04	5.25
STATISTICS	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.

Balconi C, Mazzinelli G., Lanzanova C, Torri A., Valoti P, Motto M., Berardo N. (2011) *Mais: secondo anno di sperimentazione agronomica nell'ambito del progetto Apenet*, Apoidea, 1-2, 41 – 45.

Maize sowing: what to do?



WIREWORMS: CAN IPM BE IMPLEMENTED?

1. What is the risk level? Low

2. Are IPM strategies available (e.g. monitoring methods, risk assessment, key-pest thresholds, agronomic and/or biological alternatives)? Yes, and MUTUAL FUNDS may allow IPM to be implemented rapidly.

A NEW "INSURANCE" APPROACH

MUTUAL FUNDS INSTEAD OF INSECTICIDE TREATMENTS

WHEN RISK IS LOW, THE INSURANCE APPROACH IS AFFORDABLE AND MUCH SAFER FOR PEOPLE & THE ENVIRONMENT (INCLUDING BEES)

MUTUAL FUNDS TO ALLOW RAPID AND EFFECTIVE IMPLEMENTATION OF IPM

RISKS COVERED	• Insufficient plant density (stand) due to adverse weather conditions (i.e. drought, flooding, freezing cold) • Insufficient plant density (stand) due to soil pests (e.g. wireworms, black cutworms), or diseases, such as Fusarium spp. (rotten roots, seedlings)
TARGET	Members of farmer consortia
OBLIGATIONS	• Contract to be signed before sowing; • Implementation of good cultivation practices; • Implementation of Directive 128/2009/EC; • Connection and implementation of suggestions in "Arable Crops Bulletin"
COSTS	€15/ha all inclusive (including flooding [excessive rain], freezing cold, drought); pest risk alone is covered with less than €15/ha
COMPENSATION	Up to € 500/ha including: • Resowing (up to € 250/ha) if stand below 4 pls/m^2 • Yield reduction (up to € 250/ha) based on sowing delay, crop change
COMPENSATION LIMITS	According to farm size: •Up to 10 ha: €2,000 limit; •Between 11 and 20 ha: €4,000; •> 20 ha: 10 times the total cost, or €50,000

ADVANTAGES OF MUTUAL FUNDS

1. Reduces costs/ha;
2. Covers risks due to mistakes or difficulties in IPM implementation (e.g. delay in black cutworm treatments);
3. Covers other risks, e.g. flooding and drought, not covered by insecticides;
4. Reduces health risk for farmers, as there is no contact with insecticides;
5. No negative impact of insecticides on soil beneficials;
6. No pollution risks for soil and water tables;

ADVANTAGES OF MUTUAL FUNDS

7. No risk to bees and other wild pollinators; more generally, reduces risk to fauna;
8. Covers weather risks, including weather causing soil insecticides to fail (Furlan *et al*. 2011, Ferro and Furlan, 2012, Furlan et al. 2014).

Furlan L., Benevegnu' I, Cecchin A., Chiarini F., Fracasso F., Sartori A., Manfredi V, Frigimelica G., Davanzo M.**,** Canzi S., Sartori E., Codato F., Bin O., Nadal V., Giacomel D, Contiero B (2014) *Difesa integrata del mais: come applicarla in campo*. L'Informatore Agrario, 9, Supplemento Difesa delle Colture, 11-14.

Furlan L., Cappellari C., Porrini C., Radeghieri P., Ferrari R., Pozzati M., Davanzo M., Canzi S., Saladini M.A., Alma A., Balconi C., Stocco M. (2011) *Difesa integrata del mais: come effettuarla nelle prime fasi*. L'Informatore Agrario, 7, Supplemento Difesa delle Colture: 15 – 19.

Ferro G., Furlan L. (2012) *Mais: strategie a confronto per contenere gli elateridi*, 42, L'Informatore Agrario, 42, Supplemento Difesa delle Colture: 63 – 67.

SOME SUCCESSFUL CASE STUDIES

Az. Moizzi Luciana, Eraclea (Venice)

Cultivated land: 145 ha
Reclaimed soil (1920, below sea level)
Silty loam soil, 2-3% organic matter

Conventional tillage
Rotation: winter wheat, maize, soybean
(small surface with sugar beet, 10-15 ha,
same fields every 10-12 years)

SOME SUCCESSFUL CASE STUDIES

Az. Moizzi Luciana, Eraclea (Venice)

Monitoring each year 1984 - 2014

Soil sampling in the first few years
Bait traps (larvae) from 1992
Pheromone traps (adults) from 1996

SOME SUCCESSFUL CASE STUDIES
Az. Moizzi, Italy: Results

A. brevis: negligible populations;

A. litigiosus: negligible populations;

A. sordidus: low populations (beetles < 300; larvae 0 to 0.2/tr);

A. ustulatus: 10% of the surface with high beetle-population > 1500 beetles/season; wireworm density above threshold in 3 years, total 9 ha.

SOME SUCCESSFUL CASE STUDIES
Az. Moizzi, Italy: Results

More than 1,500 hectares of maize untreated, i.e. no soil insecticide, (1984-2014);

9/1500 ha (0.60%) with economic populations (solution: replace maize with other crops);

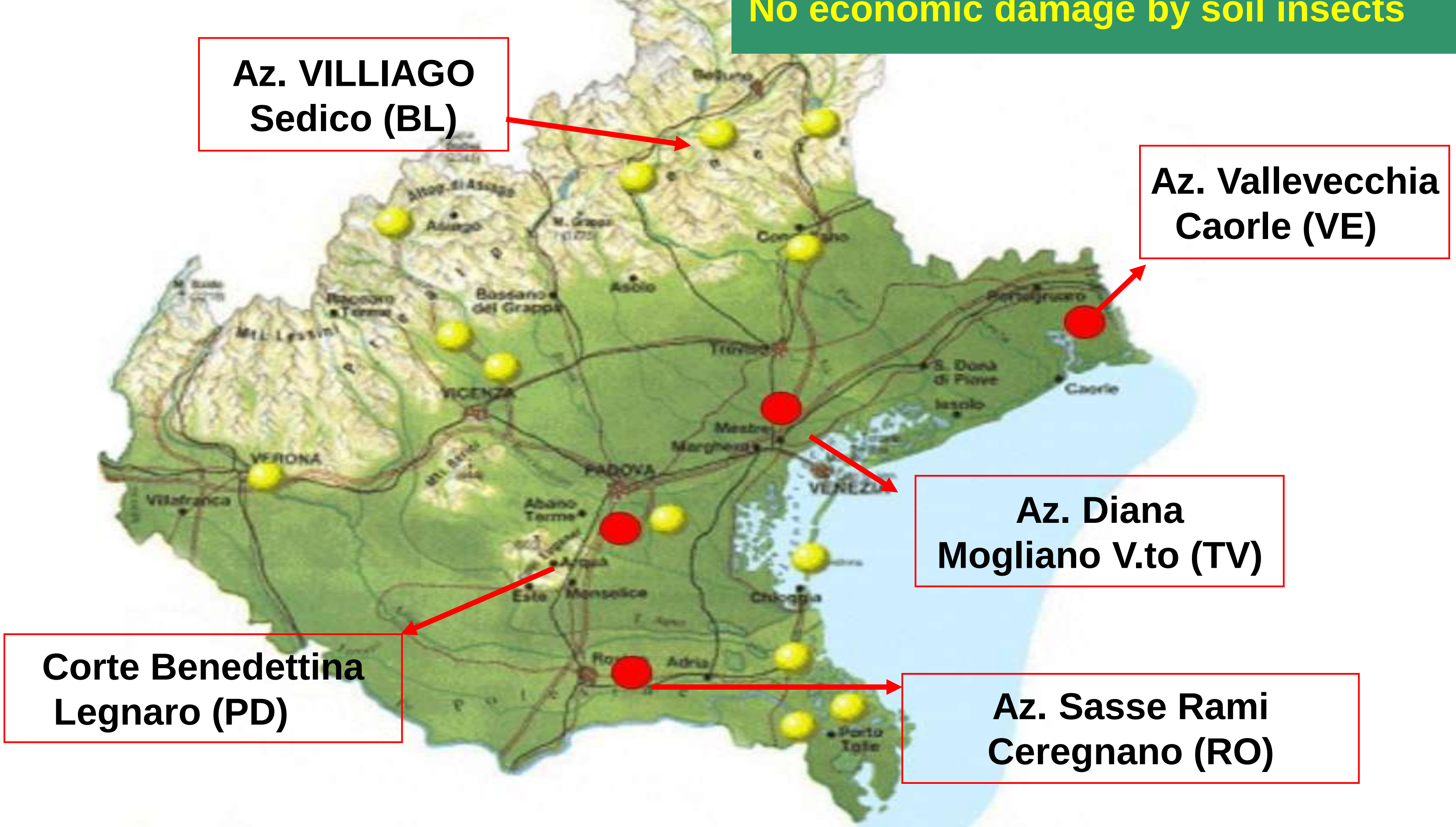
Seed/plant damage always below 5% (usually 0.1% to 2.5%);

No economic damage: 96% of fields with high stand (> 90% of sown seeds). Some cases of stand reduction (< 5 pp/m^2), mainly due to bird damage;

More than € 55,000 saved, no threat to worker health, and no environmental impact.

VENETO AGRICOLTURA OPEN FARMS - OPEN PROTOCOLS

2009 – 2014
No soil insecticides
600 ha land farmed in 6 years
170 ha maize for 6 years
> 1000 ha maize farmed over 6 years
No economic damage by soil insects



WHAT DOES IPM OF WIREWORMS INVOLVE?

Agronomic solutions (resistant/tolerant hybrids, cultivation strategies).

AGRONOMIC SOLUTIONS FOR WIREWORMS

- Changing maize position in the rotation;
- Timing tillage to increase egg and young larvae mortality;
- Others.

WHAT DOES IPM OF WIREWORMS INVOLVE?

Replacing chemicals with biological or non-chemical treatment

BIOCIDAL PLANTS AND MEAL

ALTERNATIVES TO CHEMICALS

LARGE FIELD MAIZE *Agriotes sordidus*

	stand 2 leaf plants/mq		stand 4 leaf plants/mq		damaged plants/18 m 3		damaged plants/18 m 5		damaged plants/18 m 7	
Untreated	6,05	ab	6,39	a	2,88	a	12,13	b	19,38	b
Regent	6,23	b	6,37	a	2,13	a	4,75	a	4,63	a
Brassica carinata (1)	5,95	a	6,31	a	1,25	a	1,13	a	4,88	a

FURLAN L., BONETTO C., COSTA B., FINOTTO A, LAZZERI L., MALAGUTI L., PATALANO G., PARKER W. (2010) The efficacy of biofumigant meals and plants to contro wireworm populations. Ind. Crops Prod., 31, 245 – 254.

WIREWORMS: CAN IPM BE IMPLEMENTED?

1. What is the risk level? Low, < 5%

2. Are IPM strategies available (e.g. monitoring methods, risk assessment, key-pest thresholds, agronomic and/or biological alternatives)? Yes

WIREWORMS: IPM ACCORDING TO DIRECTIVE 2009/128/EC

1. Treatment may be applied only once pest population levels have been estimated with monitoring and development models: Available.

2. Treatment may then be carried out only when and where monitoring has found that levels are above set economic thresholds: Available

3. When economic thresholds are exceeded, agronomic solutions, mainly rotation, should be considered to prevent damage to maize crops: Partially available.

4. When economic thresholds are exceeded and no agronomic solutions are available, biological control, or any other non-chemical pest control method, should be considered as a replacement for chemical treatment: Available.

PESTICIDES AND HARMFUL ORGANISMS

- Soil insecticides (e.g. wireworms, WCR);
- Herbicides;
- Post-emergence insecticides (to fight black cutworms, ECB);
- Fungicides (e.g. seedling diseases, Fusarium).

HERBICIDES

Herbicides are a key category.

Almost 100% of conventional fields (CON) are treated with herbicides.

Risk is very high.
Most fields have
an economic weed density.

HERBICIDES

PURE project focused on
Integrated Weed Management (IWM)
and evaluated a range of
non-chemical solutions.

HERBICIDES

Objectives

- Test/evaluate the efficacy of IWM tools in real field conditions in 2011-2012 against the conventional approach.

- Perform a comparative assessment of their economic sustainability.

EXPERIMENTAL SITES AND DESIGN

Nine experiments were carried out in:

1. a Southern European climate – Italy (5 farms)
2. a Central European climate – Germany (2 farms),
3. an Eastern European climate – Slovenia (2 farms).

• 3 x 0.5 ha plots (CON, IWM) used to assess the efficacy of IPM solutions against the conventional approach.

Plot A: conventional strategy (CON)

Plot B: IWM tool (IWM)

• Replications involved several farms in different countries (minimum of two farms per country).

• On-farm experiments were managed with commercially available equipment, suited to field-scale applications.

• To highlight the effect of IPM on grain yield, the CON crop management technique was used on all fields, thus IPM and CON plots differed only in the weed management type.

IPM STRATEGIES TESTED AGAINST WEEDS

The following IPM strategies were established (based on Meissle et al., 2010; Vasileiadis et al., 2011, 2013 and after discussion with stakeholders) and tested against weeds in each country

1. Early post-emergence herbicide in broadcast application when/if scouting and forecasting model (ALERTINF; Masin et al., 2010) deemed it necessary, followed by hoeing in Italy;
2. Early post-emergence in band application combined with hoeing followed by hoeing again in Germany;
3. Harrowing at 2-3 maize leave stage and low dose of post-emergence herbicide in Slovenia.

WEED MANAGEMENT (2011-2012)

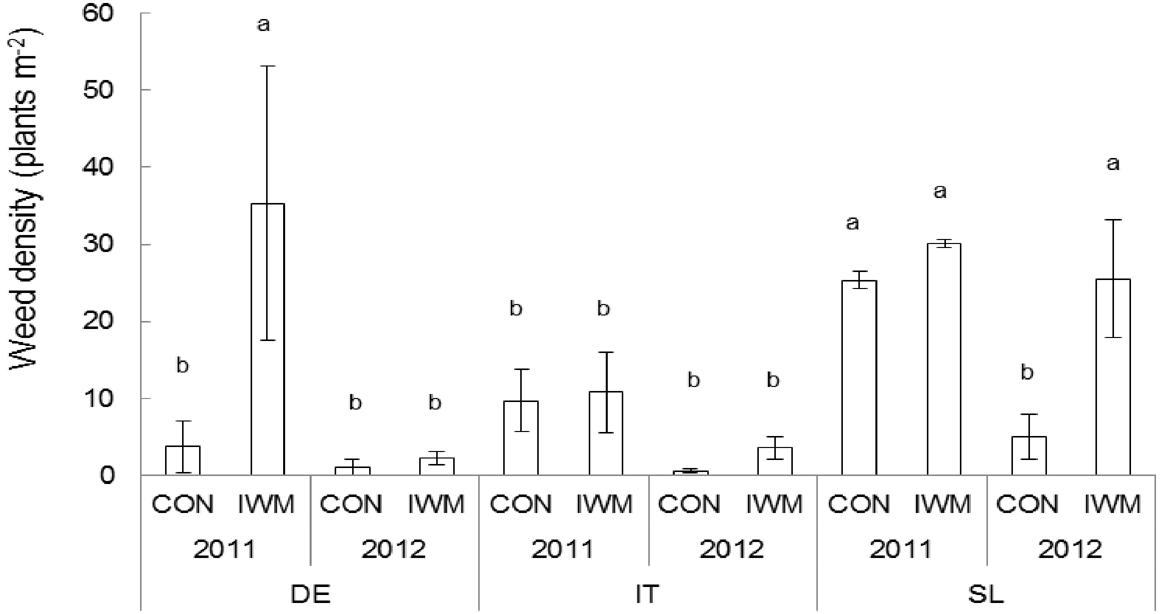
		Conventional weed management			Integrated weed management		
Farm/Country	Year	Pre-emergence herbicide	Post-emergence herbicide	Hoeing	Pre-emergence herbicide	Early post-emergence herbicide or other treatment	Hoeing
Herbolzheim 1, DE	2011	NO	x	NO	NO	band spraying combined with hoeing	x
	2012	NO	x	NO	NO	band spraying combined with hoeing	x
Herbolzheim 2, DE	2011	NO	x	NO	NO	band spraying combined with hoeing	x
	2012	NO	x	NO	NO	band spraying combined with hoeing	x
Caorle, IT	2011	x	x	x	NO	Scouting & model indicated no application	x
	2012	x	x	x	NO	x	x
Mogliano, IT	2011	x	x	x	NO	Scouting & model indicated no application	x
	2012	x	NO	x	NO	x	x
Ceregnano, IT	2011	x	NO	x	NO	Scouting & model indicated no application	x
	2012	x	NO	x	NO	x	x
Berra, IT	2011	x	x	x	NO	Scouting & model indicated no application	x
	2012	x	NO	x	NO	x	x
Ravenna, IT	2011	x	x	x	NO	Scouting & model indicated no application	x
	2012	x	NO	x	NO	Scouting & model indicated no application	x
Jablje, SL	2011	NO	x	NO	NO	Harrowing + reduced doses of herbicdes	NO
	2012	NO	x	NO	NO	Harrowing + reduced doses of herbicdes	NO
Rakican, SL	2011	NO	x	NO	NO	Harrowing + reduced doses of herbicdes	NO
	2012	NO	x	NO	NO	Harrowing + reduced doses of herbicdes	NO
Debrecen, HU (1-4 farms)	2011	NO	x	x	NO	band spraying	x
	2012	NO	x	x	NO	band spraying	x

COST-BENEFIT ANALYSIS

- Total costs
  - Inputs (seeds, pesticides, herbicides, biological agents, fertilisers)
  - Application costs
    - Own mechanisation (Labour, Machinery, Fuel)
    - Contract work

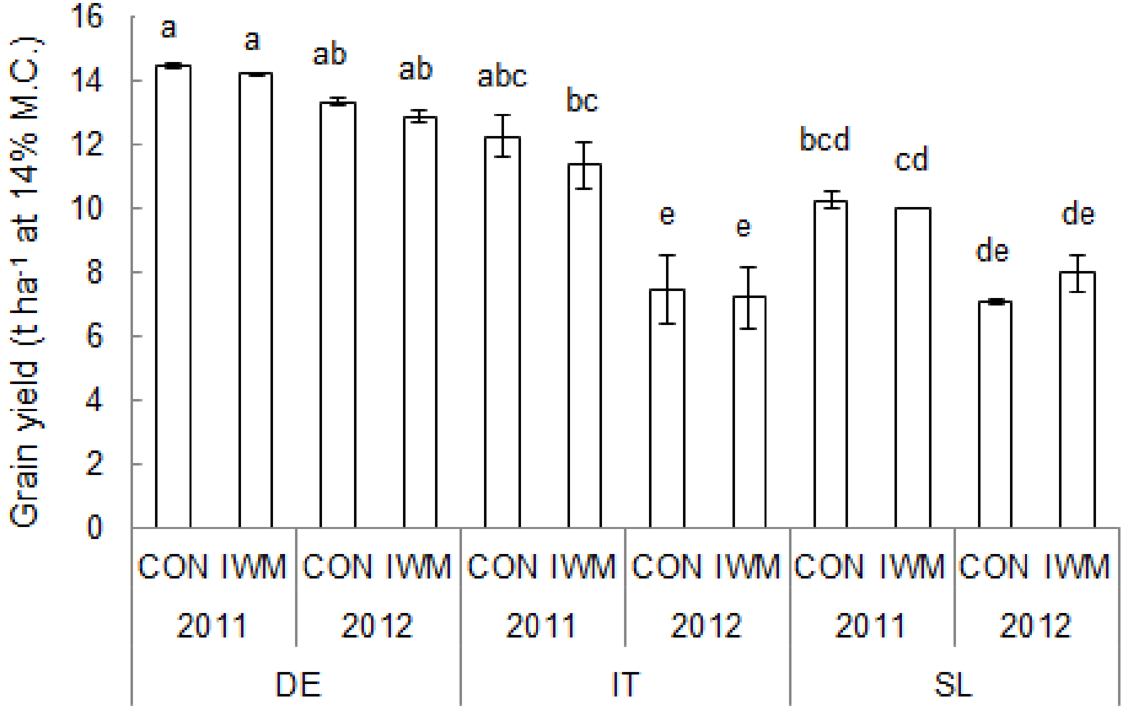
- Gross margin
  - Gross margin=Financial yield (Physical yield x Price) minus the Costs

EFFICACY: IWM VS. CON



- IWM in Italy had similar efficacy as CON in both years;
- In Germany 2011, *C. album* and *C. polyspermum* were not controlled efficiently with hoeing operations between maize rows in IWM due to a late entry for the second hoeing due to 100 mm of rain in June at the start of the second hoeing stage;
- In Slovenia 2012, the final weed density was higher in IWM as weather conditions didn't allow crops to enter 2-3rd maize leaf stage, and tine harrowing and reduced rates of herbicides allowed *A. retroflexus*, *C. polyspermum* and *E. crus-galli to emerge*

YIELD: IWM VS CON



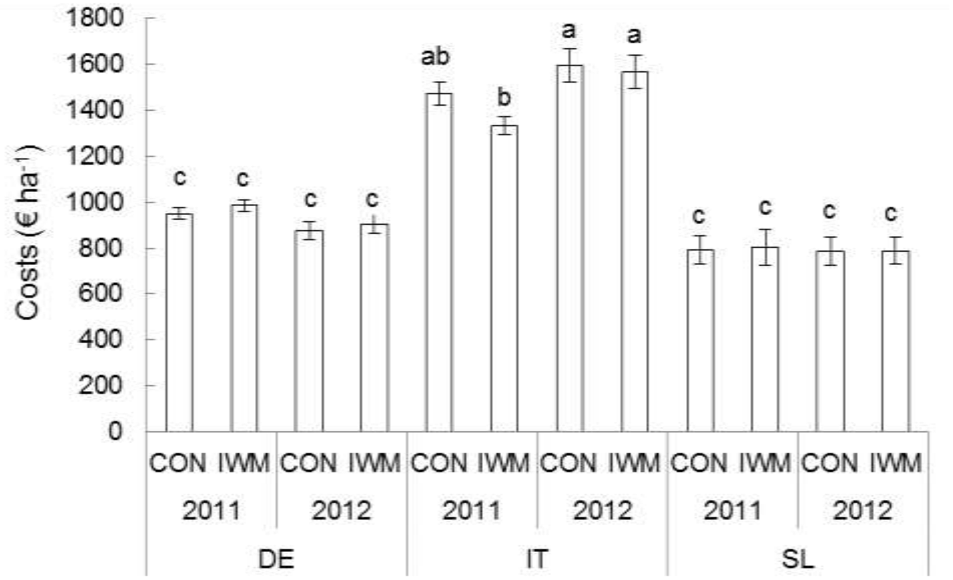
- Both years showed no significant differences in grain yield between conventional and IWM tools tested in all countries;
- In 2012, a very dry summer affected yields in Slovenia and Italy, thus the effect of weed management was not very clear, especially in Slovenia, which had high final weed densities that year.

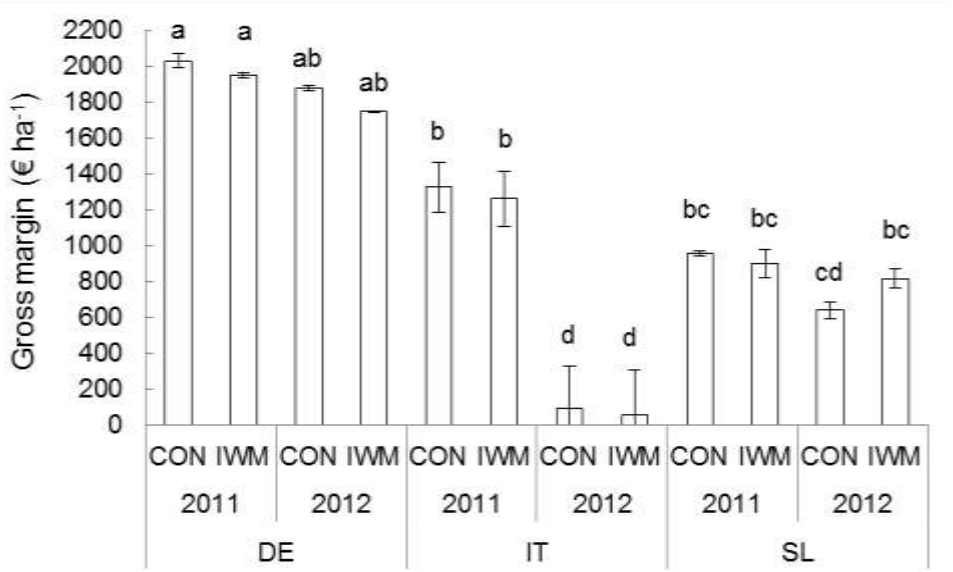
HERBICIDE REDUCTION: IWM VS CON

	CON	Mean TFI	IWM tool tested	Mean TFI
		CON		**IWM**
DE	Post-emergence herbicide in broadcast	2	Band application, plus hoeing	**0.6**
IT	Pre- and post-emergence herbicide, plus hoeing	2.2	Scouting/predictive model for spray decisions, plus hoeing	**0.8**
SL	Post-emergence herbicide in broadcast	1.4	Tine harrowing and reduced herbicide doses	**0.9**

[b] Treatment frequency index, number of full rate treatment: $TFI = 1/n\sum_{t=1}^{t=T} D_t / DAp_t$ with n: number of years in the crop sequence, T: total number of pesticide treatments, D: applied rate in commercial product, DAp: approved/registered rate for the commercial product.

GROSS MARGIN: IWM VS CON





- Costs were not significantly different in any country and year.
- In Italy, scouting and models recommended no herbicides in 5/5 farms in 2011 and in 1/5 in 2012, thus reducing costs.
- Gross margin was not significantly different in any country and year.

CONCLUSIONS ON IWM VS CON

Overall, the IWM tools tested in the three countries:

- provided sufficient weed control without any significant differences in yields;
- greatly reduced maize reliance on herbicides
- showed that IWM implementation was economically sustainable when compared to CON, as no significant differences in gross margin were observed in any country.

PESTICIDES AND HARMFUL ORGANISMS

- Soil insecticides (e.g. wireworms, WCR);
- Herbicides;
- Post-emergence insecticides (to fight black cutworms, ECB);
- Fungicides (e.g. seedling diseases, Fusarium).

ECB (SESAMIA)

ECB:
CAN IPM BE IMPLEMENTED?

1. What is the risk level? Variable, as it depends on crop use, site and year.

IPM BENEFITS BASED ON CROP USE

- **Maize for human consumption (grain)**
  ECB treatment benefits: probable, due to effects on mycotoxins;
- **Maize for animal feed (grain)**
  ECB treatment benefits: variable, depending on pest pressure;
- **Maize for animal feed (silage)**
  ECB treatment benefits: unlikely for spring sowing, probable for maize as second crop;
- **Energy use (biofermentors)**
  ECB treatment benefits: unlikely.

ECB PRESSURE

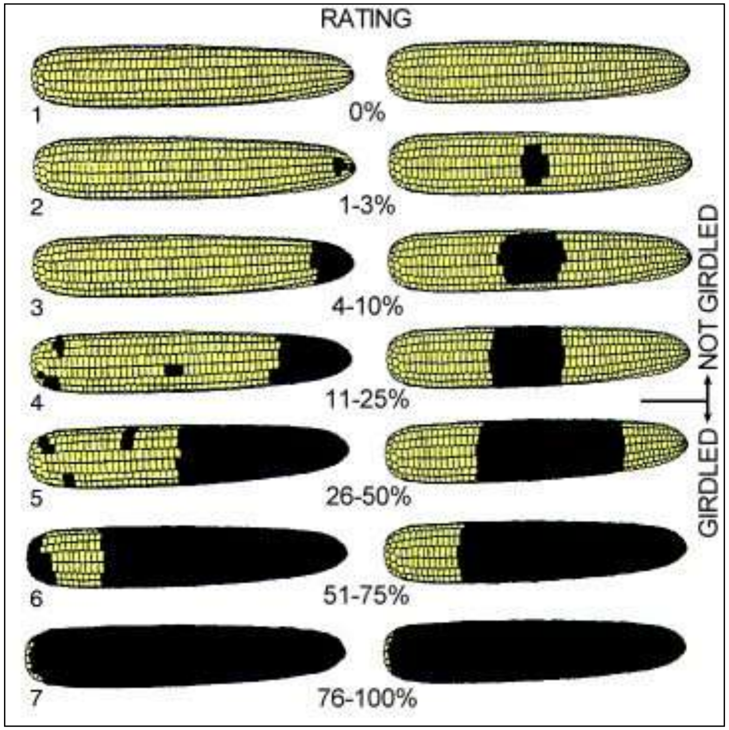
Pest pressure (damage risk) is very variable and depends on:

- The site;
- The year.

ECB TRIALS

At the same sampling areas:

- Total number of plants (final stand);
- Plants without ECB damage;
- Plants without ears;
- Plants with symptoms of ECB attack (e.g. holes on leaves);
- Plants broken above ear;
- Plants broken below ear;
- Ear damage index (1-7);
- Fusarium index (1-7).



EFFECT OF ECB TREATMENT DATE

A. 10 days before OPTIMAL DATE;

B. OPTIMAL DATE based on first eggs hatched and susceptible plant stage;

C. 10 days after OPTIMAL DATE.

Effects of treatment date for ECB control on maize in Vallevecchia

YEAR	VALLEVECCHIA	Advanced Treatment A	Optimal Treatment B	Delayed Treatment C	Untreated T
2011 Adult peak 2nd generation 7 adults/d Egg masses peak/100 pp 15.7	TREATMENT DATE	27/06/2011	12/07/2011	26/07/2011	untreated
	PLANTS BROKEN ABOVE EAR (%)	0.79 a	0.00 a	0.00 a	0.29 a
	EAR DAMAGE INDEX (1-7)	1.55 b	1.35 b	1.65 ab	1.80 a
	TOTAL FUMONISINS (B1+B2) µg/Kg	504 ± 179	27 ± 15	1572 ± 470	1121 ± 353
	GRAIN YIELD (t/ha)	8.02 a	7.83 a	8.15 a	7.68 a
2012 Adult peak 2nd generation 12 adults/d Egg masses peak/100 pp 6	TREATMENT DATE	10/07/2012	18/07/2012	27/07/2012	untreated
	PLANTS BROKEN ABOVE EAR (%)	0.95 a	0.00 a	1.00 a	1.93 a
	EAR DAMAGE INDEX (1-7)	2.53 a	2.45 a	2.20 a	2.72 a
	AFLATOXINS B1 µg/Kg	< 0.20 ± 0	5.7 ± 4.1	2.0 ± 1.6	5.8 ± 4.1
	TOTAL FUMONISINS (B1+B2) µg/Kg	6229 ±1513.3	6205 ±1583.2	6071 ±1480.6	6059 ±1478.2
	GRAIN YIELD (t/ha)	5.4 a	5.7 a	4.9 a	6.3 a

Effects of treatment date for ECB control on maize in Sasse Rami

YEAR	SASSE-RAMI	Advanced Treatment A	Optimal Treatment B	Delayed Treatment C	Untreated T
2011 Adult peak 2nd generation 10 adults/d Egg masses peak/100 pp 20	TREATMENT DATE	04/07/2011	21/07/2011	01/08/2011	untreated
	PLANTS BROKEN ABOVE EAR (%)	0.53 a	0.17 a	0.00 a	0.16 a
	EAR DAMAGE INDEX (1-7)	1.98 a	1.51 b	1.98 a	2.07 a
	TOTAL FUMONISINS (B1+B2) µg/Kg	2043 ±587	792 ±262	2483 ±693	4020 ±1043
	GRAIN YIELD (t/ha)	11.72 a	12.01 a	12.85 a	11.98 a
2012 Adult peak 2nd generation 50 adults/d Egg masses peak/100 pp 117	TREATMENT DATE	12/07/2012	19/07/2012	30/07/2012	untreated
	PLANTS BROKEN ABOVE EAR (%)	1.36 b	0.22 b	1.63 b	18.43 a
	EAR DAMAGE INDEX (1-7)	3.17 b	2.93 b	3.27 b	4.03 a
	AFLATOXINS B1 µg/Kg	78.3 ±36.6	49.3 ±24.7	39.4 ±20.3	75.5 ±35.8
	TOTAL FUMONISINS (B1+B2) µg/Kg	18000 ±3728	19000 ±3902	26000 ±5094	24000 ±4760
	GRAIN YIELD (t/ha)	5.97 a	5.94 a	5.07 ab	4.53 b

WHAT IS IPM OF ECB?

IMPLEMENTATION
OF SAMPLING/MODELS/THRESHOLDS:
treatments only after pest assessment.

IPM STRATEGY FOR ECB

1. Can we predict ECB treatment timing by evaluating pest development ?

2. Can we predict pest severity with sufficient warning to decide whether treatment is necessary?

ECB DEVELOPMENT MODEL

The biological stages of ECB can be predicted with accumulated temperature units called "degree days" and other parameters considered by a specific ECB development model:

As to T

From 1 January each year:

$\sum$ (max temp – min temp)/2 – 10°C (or 50°F)

(10°C or 50°F = threshold temperature for ECB)

FORECASTING ECB PRESSURE

- Early presence of ECB larvae on ears (silks) correlates to damage risk;
- Egg masses density, the % of ear silks with larvae levels are suitable thresholds on which the need of treatment may be decided.

ECB-IPM: two farms in two years

Regression-analysis ECB treatment B (Ampligo) peak/damage/mycotoxins

(9 records/parameter)

FARM/YEAR	Fumonisins (µg/kg)	Egg masses max/100 pp	Adult peak 2° generation	Δ Grain yield vs.Control (t/ha)	Ear damage index (1-7)	Fusarium index (1-7)
Vallevecchia/2011	27	15,7	7	0,15	1,35	1,10
Vallevecchia/2012	6205	6,0	12	-0,60	2,45	2,93
Sasserami/2011	792	20,0	10	0,03	1,51	1,58
Sasserami 2012	19000	117,0	50	1,41*	2,93	2,67
				* ANOVA (P=0,023)		

Pearson correlation test	Pearson	p-value	R^2
Adult peak 2° gen Vs.Fumonisins	0,972	0,028	0,945
Adult peak 2° gen Vs. Egg masses	0,982	0,018	0,964
Grain yeald-Control Vs. Egg masses	0,954	0,046	0,954

WHAT DOES IPM OF ECB INVOLVE?

Agronomic solutions (resistant/tolerant hybrids, cultivation strategies).

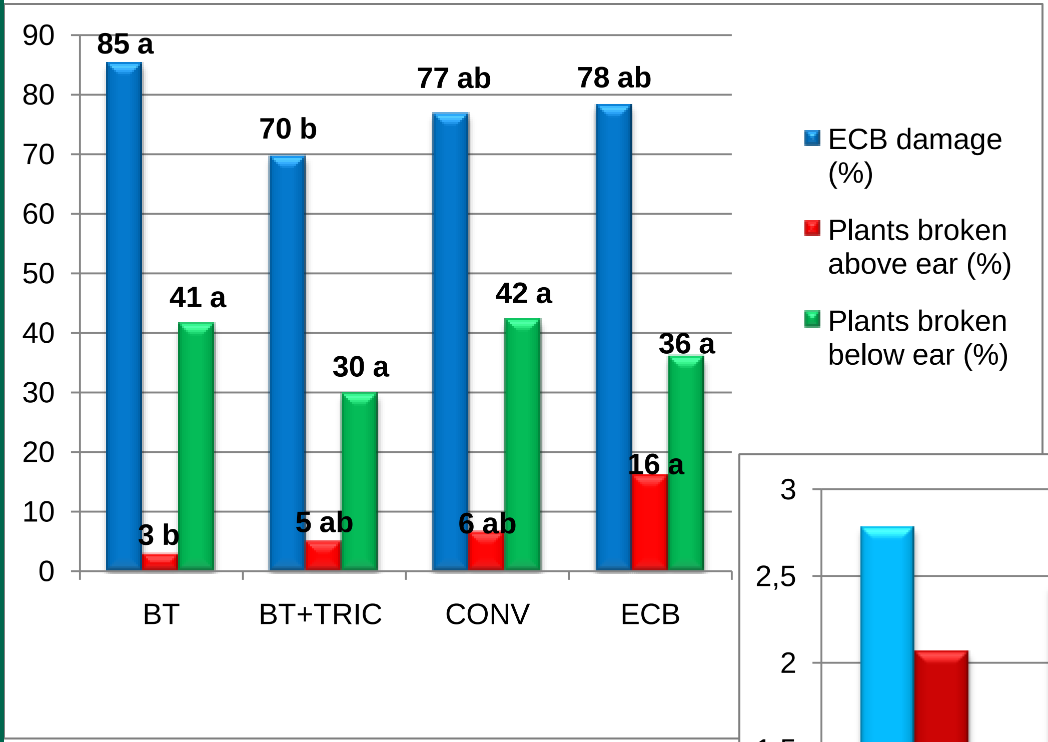
WHAT DOES IPM OF ECB INVOLVE?

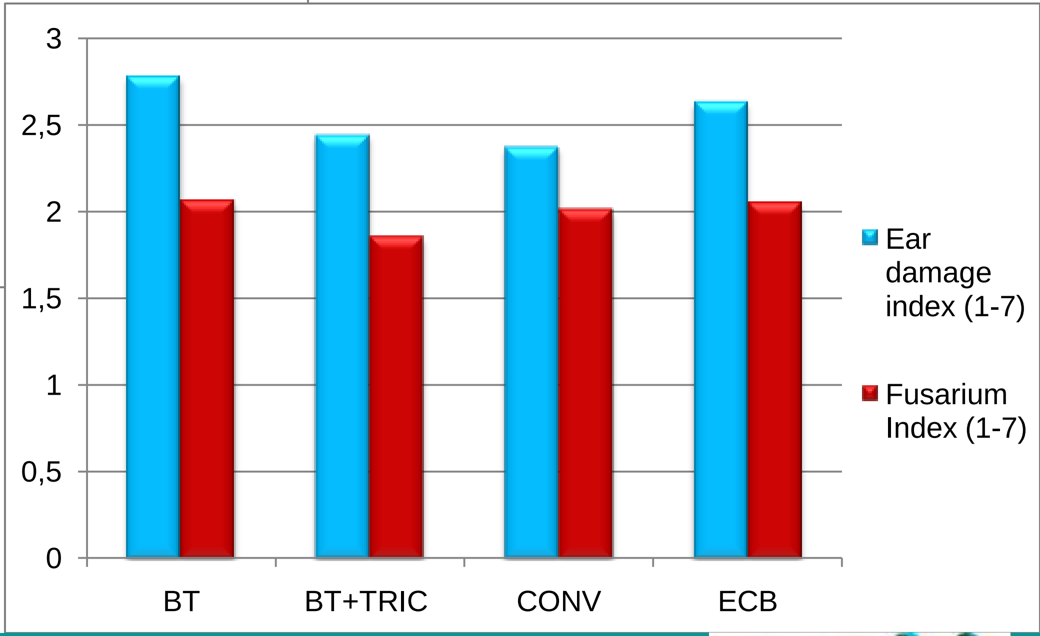
Replacing chemicals with biological tools, or less harmful pesticides.

EVALUATION OF BIOLOGICAL TOOLS IN 2012

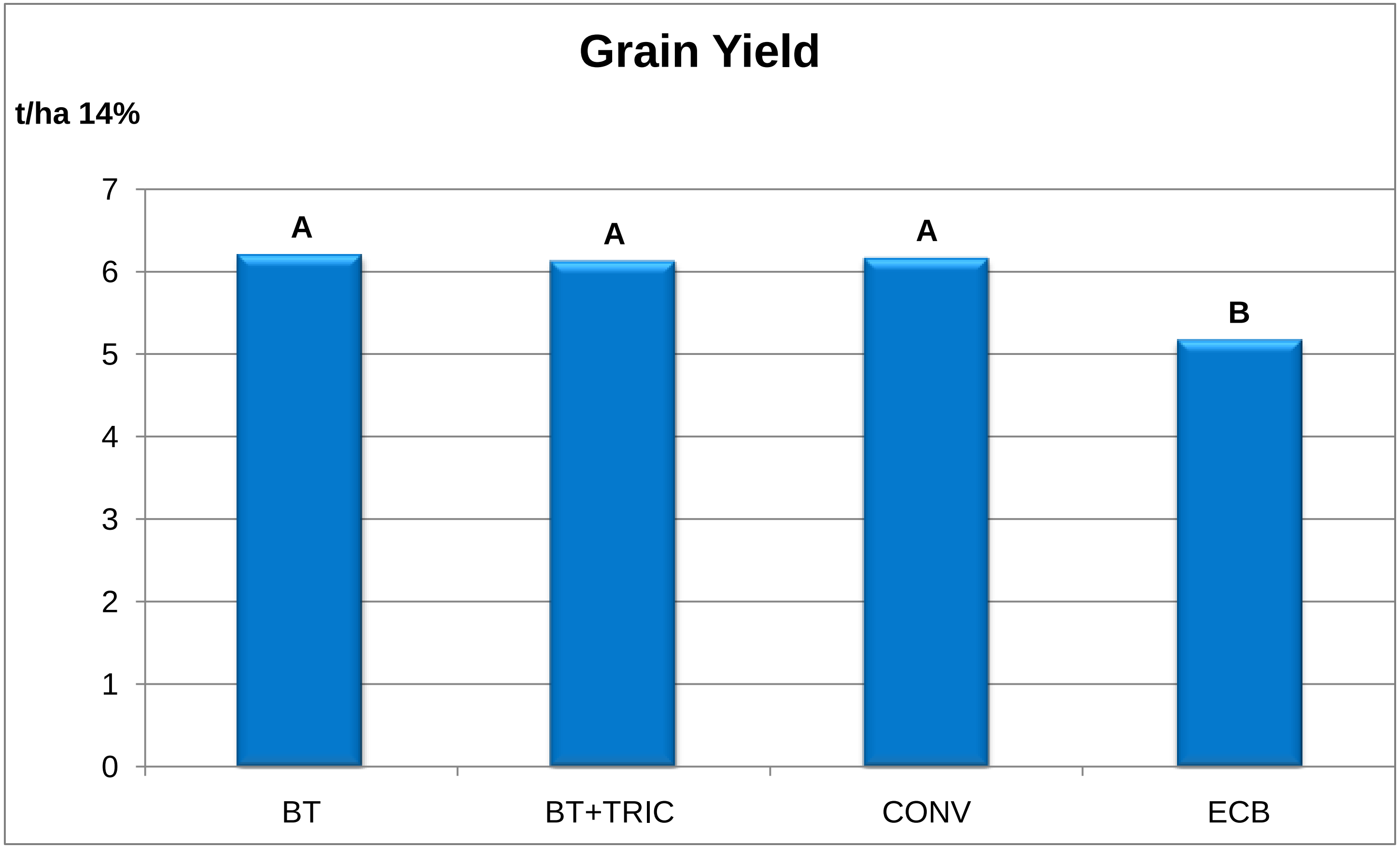
- CONV = Karate Zeon ® 200 cc/ha
- ECB = Trichogramma (2 releases)
- BT = Bacillus Thuringiensis (Biobit® 1 kg/ha)
- BT + TRIC = B. Thuringiensis (1 tr.) + Trichogramma (2 releases)

ECB RESULTS FOR DAMAGE & TREATMENTS (2012)





YIELD AFTER ECB TREATMENT (2012)



WHAT DOES IPM OF ECB INVOLVE?

OPTIMISING TREATMENT TIMING:
multi-task treatments

ECB: CAN IPM BE IMPLEMENTED?

1. What is the risk level? Low to high

2. Are IPM strategies available (e.g. monitoring methods, risk assessment, key-pest thresholds, agronomic and/or biological alternatives)? Yes

ECB: IPM ACCORDING TO DIRECTIVE 2009/128/EC

1. Treatment may be applied only once pest population levels have been estimated with monitoring and development models: Available.

2. Treatment may then be carried out only when and where monitoring has found that levels are above set economic thresholds: Being assessed.

3. When economic thresholds are exceeded, agronomic solutions, should be considered to prevent damage to maize crops: Partially available.

4. When economic thresholds are exceeded and no agronomic solutions are available, biological control, or any other non-chemical pest control method, should be considered as a replacement for chemical treatment: Available.

ECB: BULLETIN CONTENT

- General information;
- ECB development pattern;
- Risk area based on population levels;
- Egg presence;
- Interaction with WCR;
- Experiment results.

PESTICIDES AND HARMFUL ORGANISMS

- Soil insecticides (e.g. wireworms, WCR);
- Herbicides;
- Post-emergence insecticides (to fight black cutworms, ECB);
- Fungicides (e.g. seedling diseases, *Fusarium*).

FUNGICIDES

	(Healthy plants/m²)		Damaged plants		Yield
	emergence	4-6 leaves	pp/mq	%	t/ha (14%)
NAKED SEED	6.26ab	6.33a	0.148a	2.28	12.11a
FUNGICIDE	6.41b	6.58c	0.157a	2.32	12.43a
FUNGICIDE+ CRUISER	6.32ab	6.52bc	0.103a	1.56	12.22a
FUNGICIDE+ REGENT	6.15a	6.38ab	0.087a	1.35	12.31a
FUNGICIDE+ GAUCHO	6.25ab	6.44abc	0.069a	1.01	11.97a

26 fields - 504 plots (Hybrid Tevere)

Means followed by the same letter in a column are not significantly different [?] (Tukey's HSD test, $P < 0.05$).

FUNGICIDES

1. What is the risk level? long-term experiments showed that fungicide treatment is not always essential; minor part of fields had rotten seedlings or young plants; fungicide should not be used prophylactically in order to limit the risk of resistant fungi populations developing

2. Are IPM strategies available (e.g. monitoring methods, risk assessment, key-pest thresholds, agronomic and/or biological alternatives)? Yes, risk factors and monitoring methods available: consequent practical guidelines to be established; promising microbial consortia (mainly antagonists like *Trichoderma*) as biological treatments

REDEFINING IPM?

PLEASE JUST MAKE POSSIBLE IMPLEMENT DIRECTIVE 2009/128/CE

ALSO DEFINING

- **CLEAR PESTICIDE REDUCTION TARGETS**
- **DEADLINES FOR MEETING TARGETS**