Management strategies for the control of *Tuta absoluta* (Lepidoptera: Gelechiidae) and their effectiveness

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INSTITUTE OF LIFE SCIENCES

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Introduction

- Several studies have been conducted on the ecology of *Tuta absoluta* (Meyrick);
- So far, a relatively wide range of natural enemies native to the Mediterranean region have been identified;
- Limited data available on (a) **level biological control** in open-field cultivations, (b) resulting **yield loss** and (c) within-field and surroundings **natural enemy habitats** availability
- Habitat management strategies for controlling exotic species have been recently reviewed (Jonsson et al. 2010)

Introduction

Type	Plant-feeding stage	Family	Plant-derived resources
Life-history omnivory	Adult	Ichneumonoidea	Nectar
		Vespidae	Nectar, fruit
		Formicidae	Nectar
Temporal Omnivory	Adult	Ichneumonoidea	Nectar
	Juvenile	Araneidae	Pollen
Permanent Omnivory	Adult & Juvenile	Phytoseiidae	Nectar, pollen
		Miridae	Plant juice
		Geocoridae	Plant juice
		Anthocoridae	Pollen
		Coccinelidae	Nectar
		Carabidae	Pollen, seeds

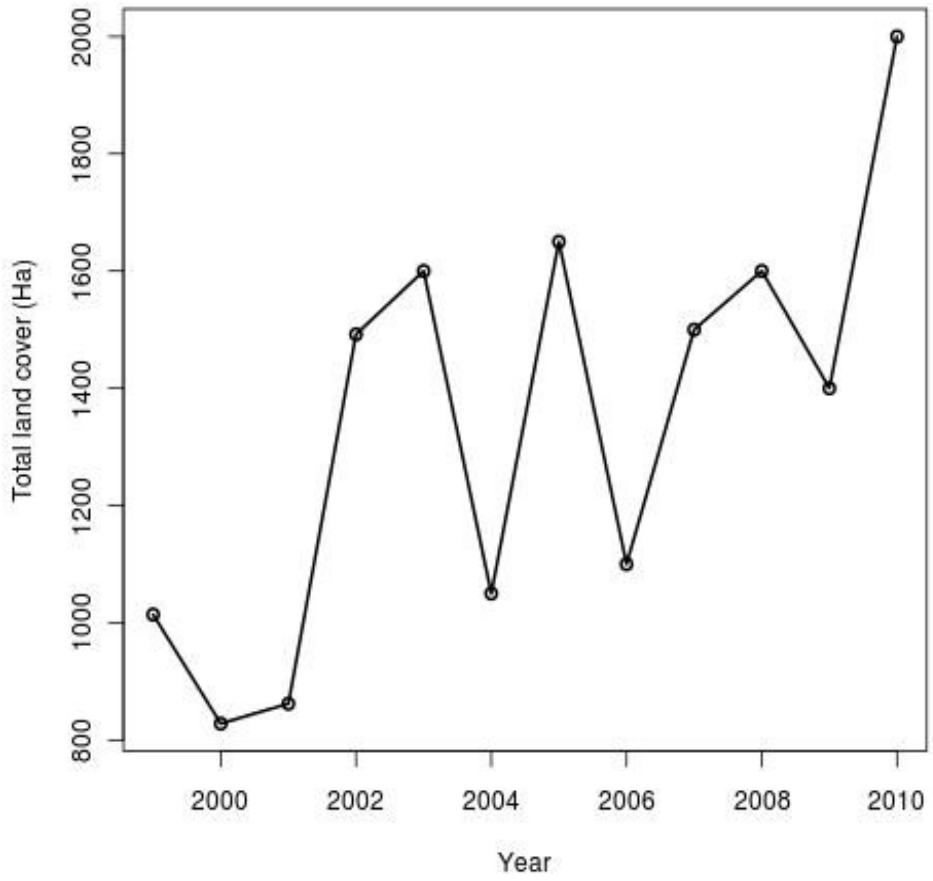
Adapted from Wackers (2005)

Research aims

- To monitor spatio-temporal distribution of *T. absoluta* in processing tomatoes cultivations in Tuscany, Italy
- What management practices are utilised by farmers for the control of this pest within the area of study?

Processing tomato cultivations

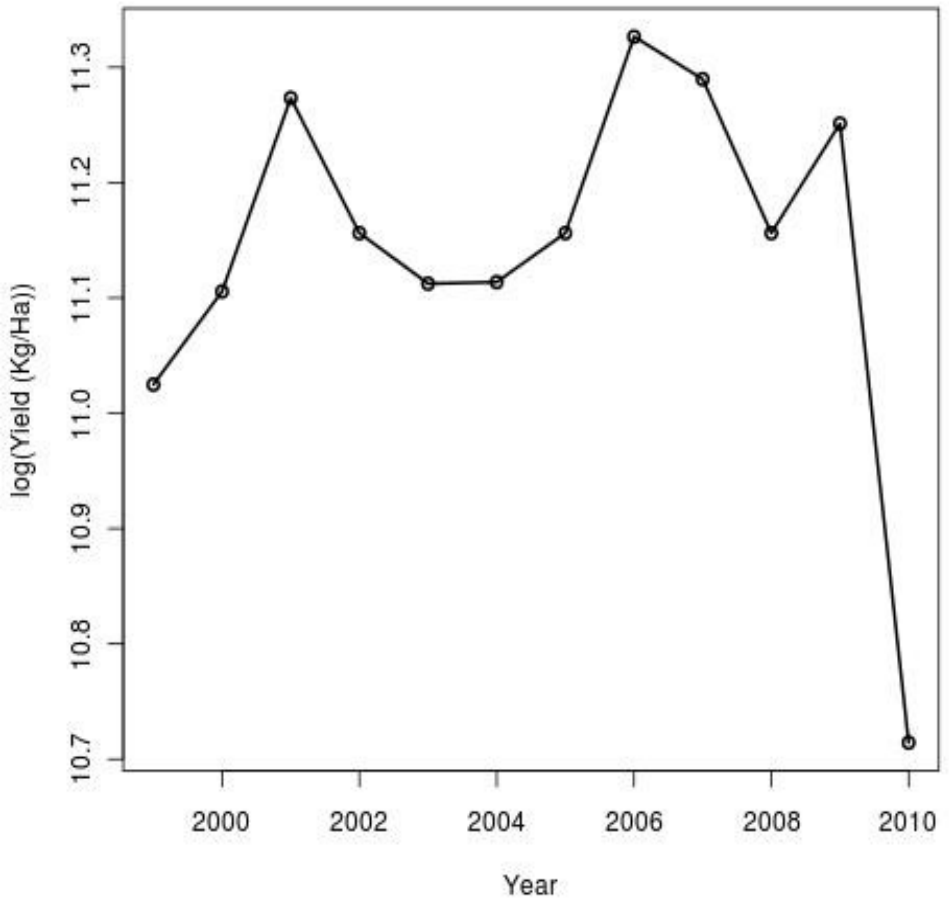
- Open field-cultivations of processing tomato the most important horticultural crop in Grosseto.
- Dedicated land cover has increased overall during the last decade.



From ISTAT data (http://agri.istat.it/)

Processing tomato cultivations

- First records of *T. absoluta* within the region from Grosseto in 2009 (Bagnoli et al. 2010).
- In 2010 a major drop in yield (kg/ha) was observed

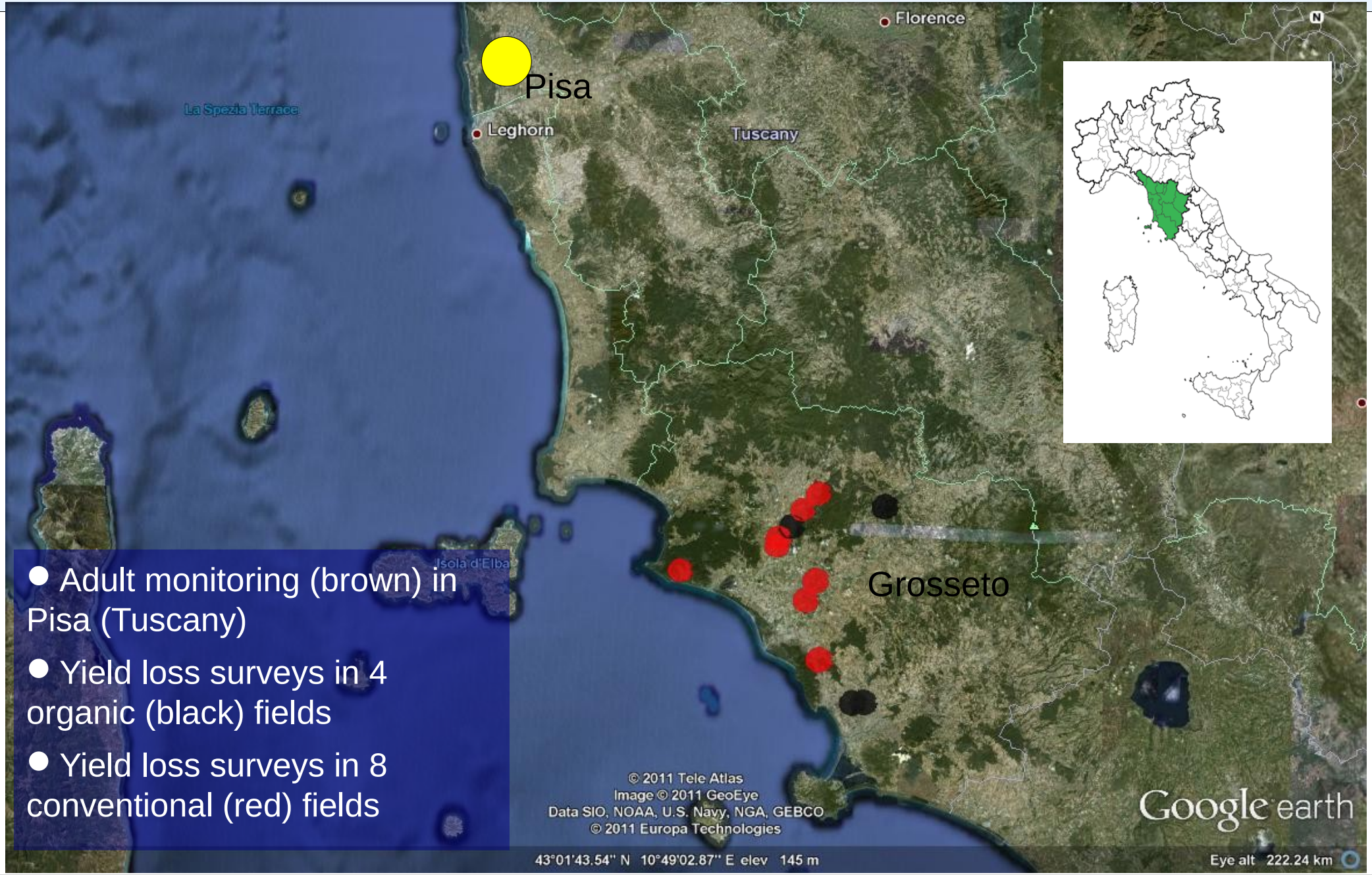


From ISTAT data (http://agri.istat.it/)

Research Questions

- IPM strategies should based on different monitoring strategies (pheromone lures, yield loss counts) and diversified pest control techniques.
  - How does adult population of *T. absoluta* change with time across the life-cycle of the crop? **- Pheromone lures**
  - What is the magnitude of pest damage from *T. absoluta* in organically and conventionally managed field? **– Yield Loss/Gallery abundance counts**
  - Which PM strategies are utilised by farmers within the study area? **- Pesticide records/Farmers' Questionnaire**

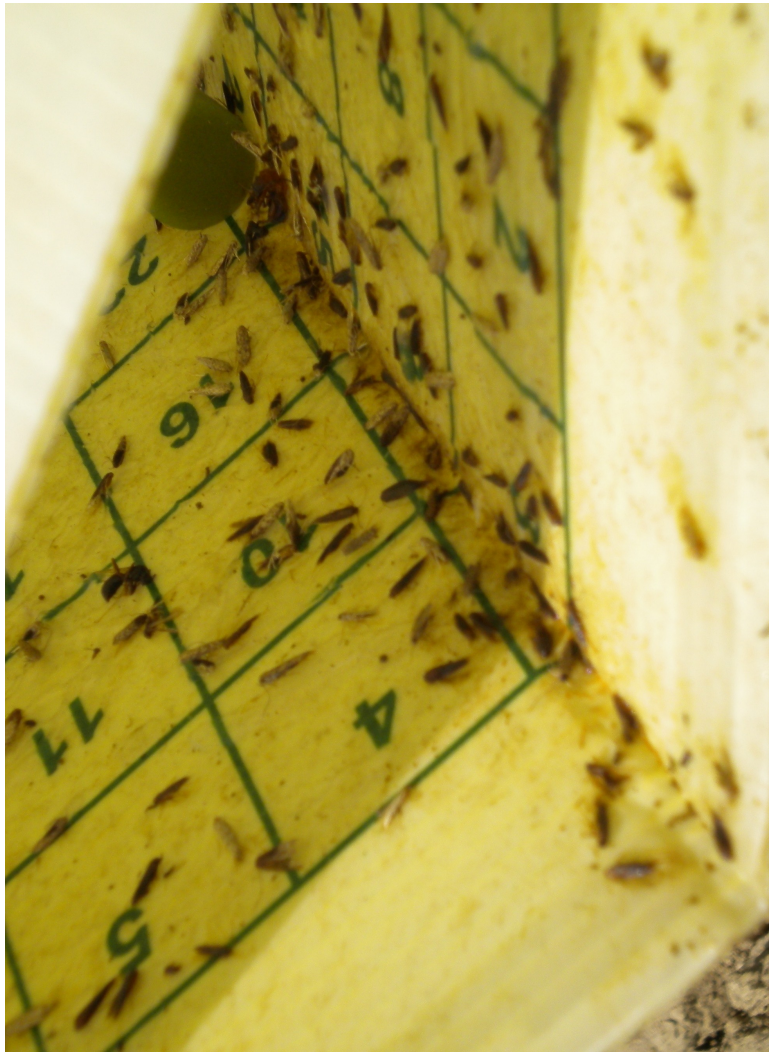
Study Area



- Adult monitoring (brown) in Pisa (Tuscany)
- Yield loss surveys in 4 organic (black) fields
- Yield loss surveys in 8 conventional (red) fields

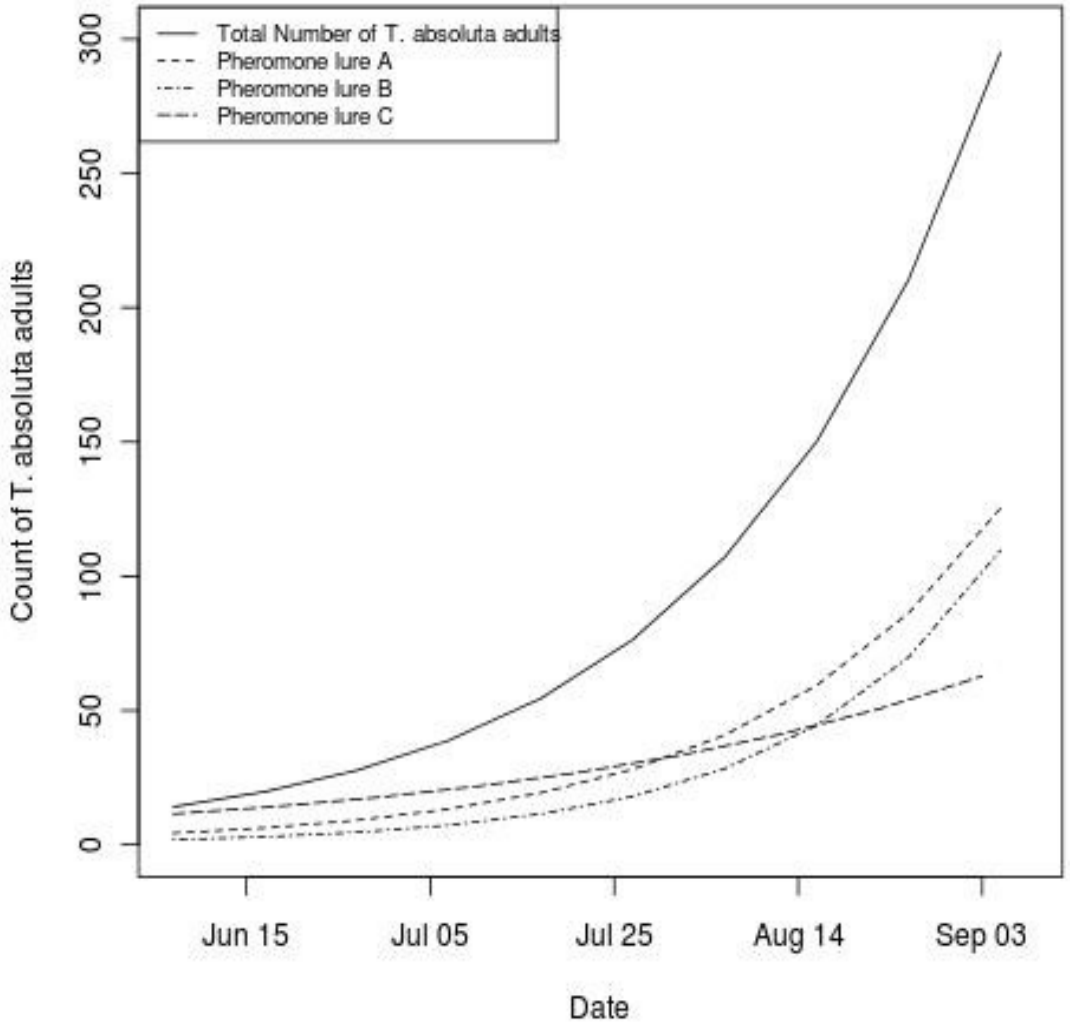
Methodology

- **Pheromone lures**
  - Three traps in organically-managed cultivations in Pisa (Italy);
  - Site forms part of organically-managed experimental fields in a natural park;
  - Monitored weekly;
  - A generalised linear model (GLM), using a quasi-poisson distribution fitted on count data.



Results

- **Pheromone lures**
  - Exponential increase in population counts;
  - Counts reach an average of 105 adults/trap/week just before harvest, soon after the first week of September.



Methodology

- **Yield loss in conventionally managed farms**
  - Field surveys in 8 fields in the growing seasons of 2010 and 2011;
  - 4 fields/year
  - Sampling date was carried out 7-14 days before harvest;
  - A grid of 15 (large fields) and 9 (small fields) sampling points was used in 2010.
  - A grid of 12 sampling points used for all fields in 2011
  - Each point consists of a $1m^2$ quadrat.
  - Gallery abundance measured in middle and upper-canopy fruits for 5 minutes.

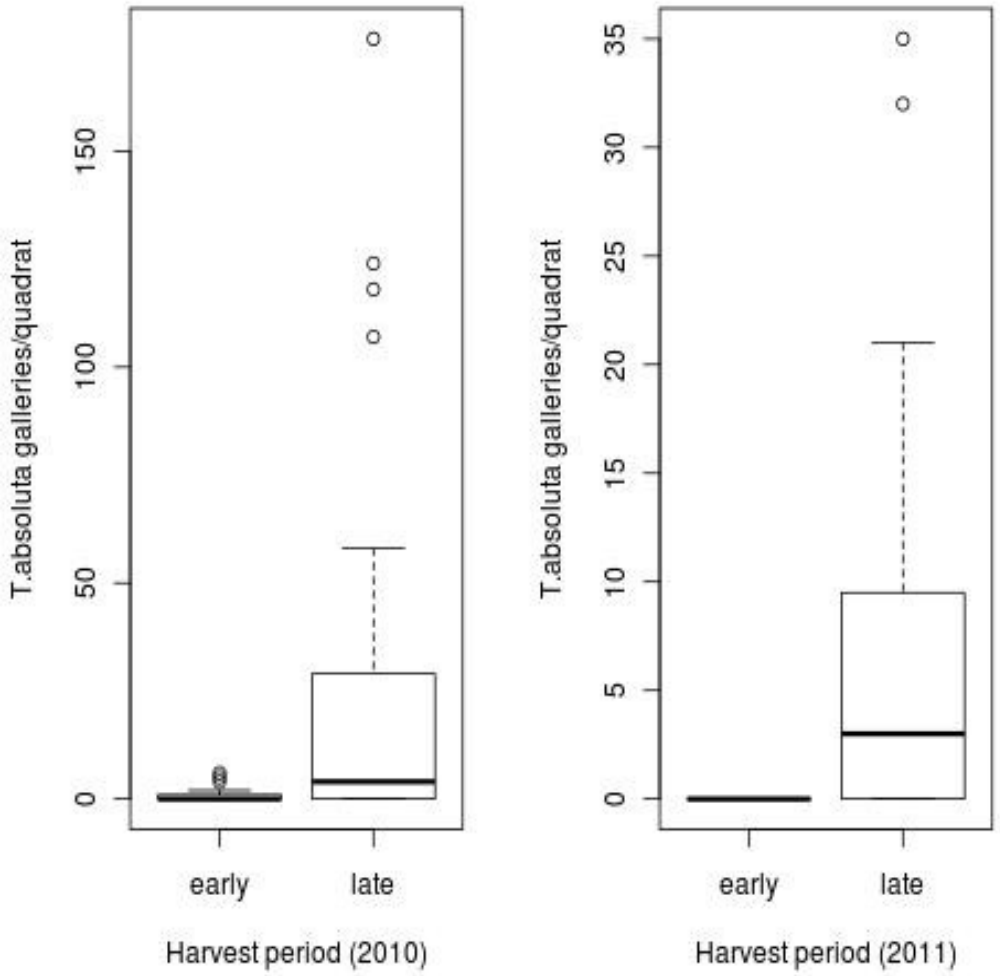
Results

- **Yield loss in conventionally managed farms**
  - Recorded in nearly all surveyed fields, except for tomatoes harvested early (June-July) during the growing season of 2011
  - Always higher during 2010
  - Generalised linear model suggests that both harvest period and year significantly influence gallery abundance.

Factor	**t-value**	**p-value**
Harvest period	3.65	<0.0001
Year	-3.53	<0.0001

Results

- **Yield loss in conventionally managed farms**



Methodology

- **Yield loss in organic fields**
  - Leaf and fruit gallery abundance monitored in a sampling grid of 60 points/field;
  - A survey of 4 organically-managed field carried out between June-September, 2011
  - For each sample gallery abundance in two upper-canopy leafs and five fruits were recorded

Results

- **Yield loss in organic fields**
  - Gallery abundance of larval stages of *T. absoluta* remained relatively low in all 4 sampled fields throughout the growing season

Field	Mean galleries/leaf	Mean galleries/fruit
A	0.025 ± 0.143 b	0.007 ± 0.052 a
B	0.075 ± 0.289 ab	0.020 ± 0.088 ab
C	0.117 ± 0.282 a	0 ± 0.000 b
D	0.025 ± 0.110 b	0 ± 0.000 b

Methodology

- **Farmers' Pest Management (PM) strategies**
  - Pesticide records for organic and conventionally-managed fields
  - Semi-open interviews with conventional-fields farmers from 2010

Methodology

- **Farmers' PM strategies – Perceptions and decision-making indicators**
  - Monitoring strategies
  - “If and when” decision
  - Ecology of *T. absoluta*
  - Habitat management – providing habitat and resources for natural enemies

Results

- **Farmers' PM Strategies**
  - Organic farms
    - Insecticide applications recorded from 3 (out of 4) fields
    - For two fields (A, B) pest management was mainly based on Bt applications every fortnight
    - Field C only one application of pyrethrine

Results

- **Farmers' PM Strategies**
  - Conventionally-managed fields
    - Altogether interviewed farmers managed a total of 291ha dedicated to conventionally-managed tomato in 2010
    - PM largely based on chemical inputs

Results

Conventional Farm	1	2	3	4
Land cover (ha)	150	35	102	2
Pheromone trapping (Noctuidae)	Y	N	Y	N
Pheromone trapping (T. absoluta)	N	N	N	N
PM strategy	Noctuidae traps treshold; visual estimations of yield loss	Calendar-based treatments	Calendar-based treatments	Calendar-based treatments
Active ingredients	Deltamethrin; Lambda-cyhalothrin	Deltamethrin; Lambda-cyhalothrin	Indoxacarb; Lambda-cyhalothrin	Indoxacarb; Spinosad

Results

- **Farmers' PM strategies – Perceptions and decision-making indicators**
  - Low use of pheromone lures and yield loss monitoring;
  - Calendar-based (every 15-25 days) insecticide applications
  - Farmers' identified within-field herbaceous and weed species as potential host plants for *T. absoluta* (but most were unable to identify any plant species with the exception of one person who identified *Solanum nigrum*)

Results

- **Farmers' PM strategies – Habitat Management**
  - Uncultivated field edges managed through chemical and mechanical measures
  - System characterised by high levels of ecological disturbances, likely to compromise biological control
    - Calendar based pesticides (fungicides, herbicides, insecticides)

PM strategies

Pesticide side effects used in conventional (& organic*) cultivations in Grosseto on selected taxa of natural enemies & their toxicity

Active ingredient	Type	Pedatory mites (*Typhlodromus pyri*)	Predatory mites (*Phytoseiulus persimilis*)	Spiders (*Pardosa* spp.)	Flower bugs (*Anthocoris nemoralis*)	Coccinelidae (*Coccinella septempunctata*)	Parasitoids (*Aphidius rhopalosiphi*)	Parasitoids (*Trichogramma cacoeciae*)	WHO toxicity class
Fosetyl-Al	F	N	N		M	N	N	M	U
Mancozeb	F	T	T		M	N	N	T	U
Glyphosate	H	M	M		N		N	M	U
Deltamethrin	I	T	T		T	T		T	II
Imidacloprid	I	N	N	T	T	T	T	T	II
Indoxacarb	I	N	N		M	M		M	III
Lambda-cyhalothrin	I	T	T	T	T	T		T	II
Pyrethrine*	I	N			M			M	II

IOBC (field & semi-field) classification: N = harmless or slightly (reduction 0+50%); M= moderately harmful (reduction 51-75%); T = harmful (reduction > 75%)

WHO classification: U = Unlikely to present acute hazard in normal use; III=Slightly hazardous; II=Moderately hazardous

Conclusion

- *T. absoluta* has become established throughout the area of study and different PM practices;
- Low *T. absoluta*-caused damage recorded in 2011 throughout all trials, and yield loss normally associated with tomatoes harvested later (September) in the season;
- Current PM strategies mainly based on insecticides use;
- Potential for IPM strategies

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