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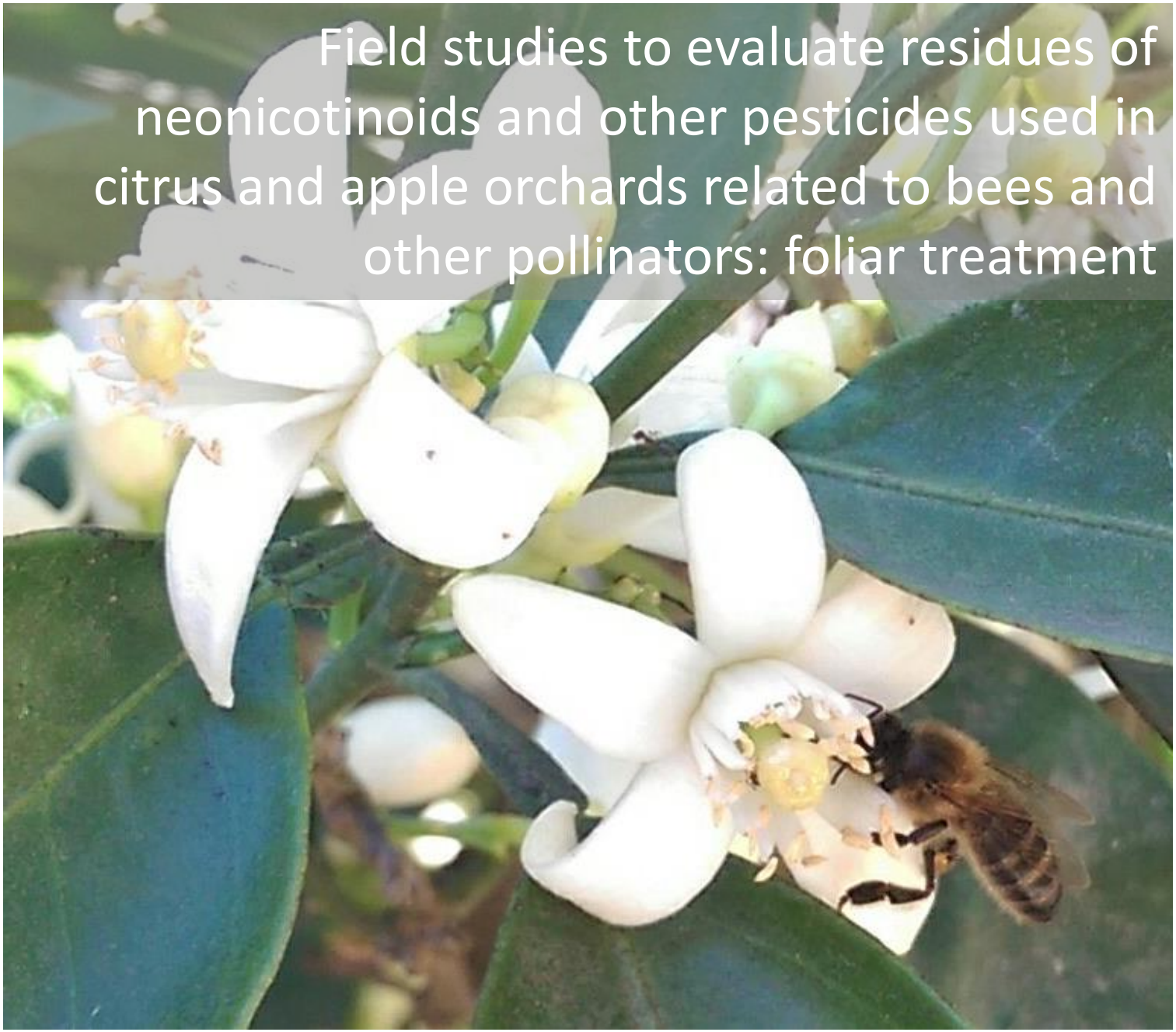
Field studies to evaluate residues of neonicotinoids and other pesticides used in citrus and apple orchards related to bees and other pollinators: foliar treatment



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Apple

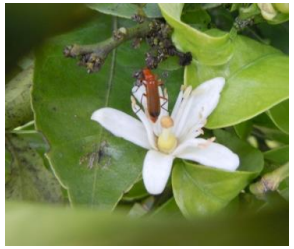
- Bees are used in apple tree plots to improve pollination. Placing beehives in the fields is a standard practice.
- Neonicotinoids and other insecticides and fungicides, acaricides, growth regulators and herbicides are sprayed in pre and posflowering.
- Fungicides and antibacterial to prevent fireblight (*Erwinia amylovora*) during flowering (with beehives in the fields) are sprayed
- The influence of these treatments on bee populations is unknown.

Citrus

- Orange blossom honey: Higher price
- Most varieties of citrus in Spain cultivate are parthenocarpic
- Citrus growing and beekeeping

- New flushes: Spring, summer and autumn
- Pests associated with new flushes: neonicotinoids and other pesticides
  - ✓ *Aphids, leaf miner, whiteflies*

Citrus and apple orchards



Integrated Production standards promote biodiversity agrosystem by maintaining groundcovers

High volumes applied by air blasts sprayers

OBJECTIVES

- ✓Neonicotinoids residues in pollen and nectar of apple and citrus flowers and in groundcover flowers after foliar sprays

- ✓IPM citrus and apple growing areas. Pesticide residues in pollen from tree flowers, bees, and pollen collected by bees. Pollinators biodiversity.

- ✓Semi field studies under greenhouses. Neonicotinoids residues in pollen and nectar of apple and citrus flowers, bees, pollen collected by bees and bee wax.

OBJECTIVE 1

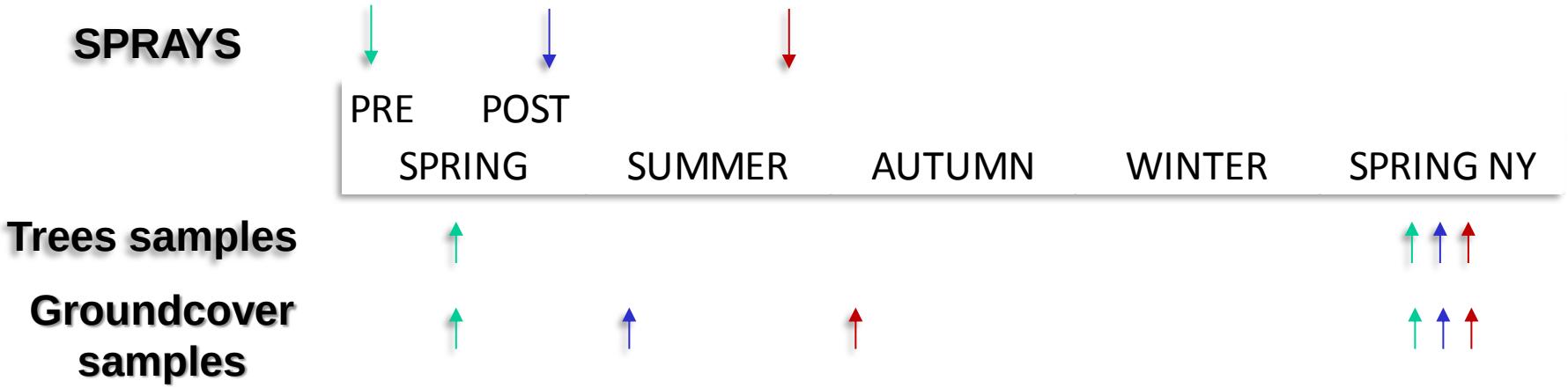
Neonicotinoids residues after foliar sprays in

i) pollen and nectar of apple and citrus flowers
ii) groundcover flowers

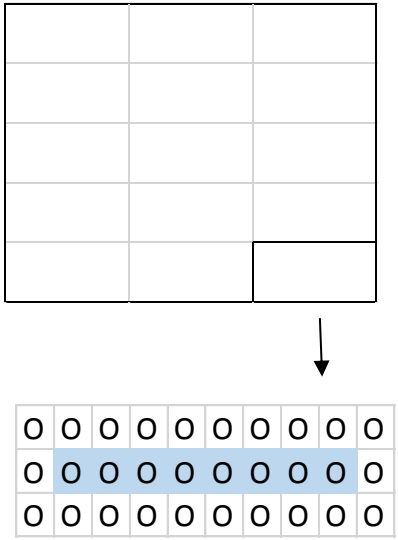
Neonicotinoids residues i) in pollen and nectar of apple and citrus flowers and ii) in groundcover flowers after foliar sprays

Imidacloprid, tiacloprid and acetamiprid: apple

Imidacloprid and tiametoxam: citrus



FOLIAR SPRAY IN APPLE ORCHARD

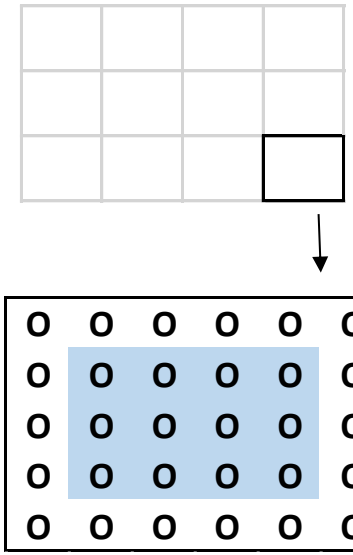


30 trees
37 m²

1640 m²

P=6 atm; V=1.000 l/ha

FOLIAR SPRAY IN CITRUS ORCHARD



30 trees
600m²

7200 m²

P=10 atm; V=2.000 l/ha

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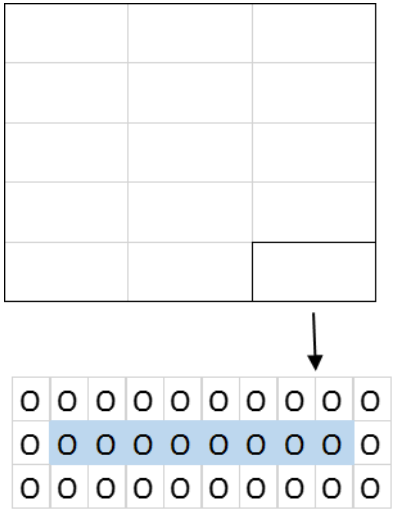
Big plots; Drift; Machinery contamination

Sampling apple flowers (pollen and nectar)



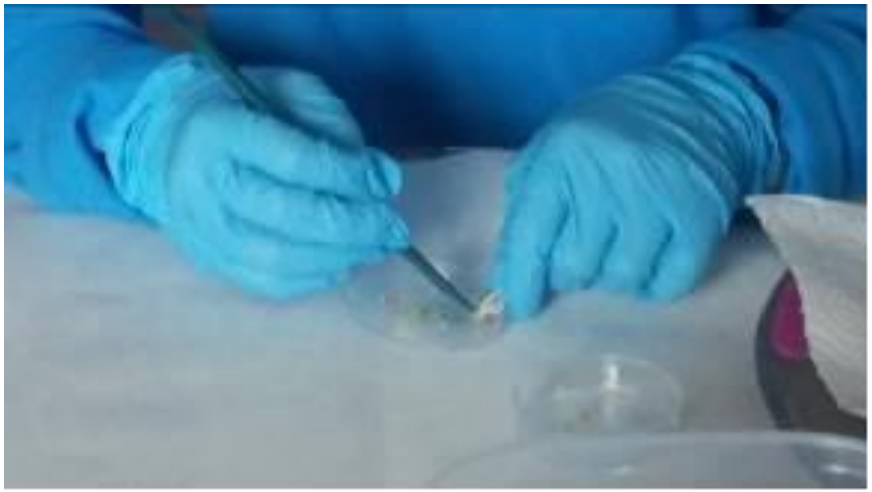
- Apple >250 flowers

  2 g pollen

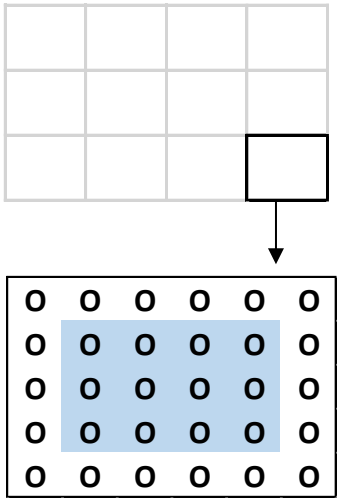
  200 µl nectar

Three samples per plot:

- 10% flowering
- 30-40% flowering
- 70-80% flowering



Sampling citrus flowers (pollen and nectar)



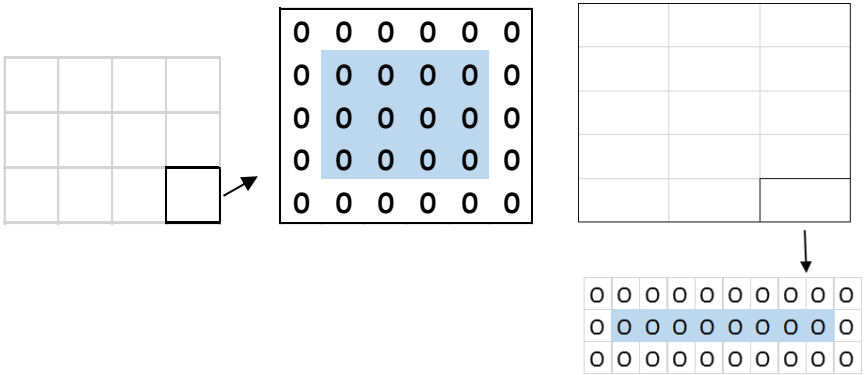
2 g pollen

200 µl nectar

Three samples per plot:

- 10% flowering
- 30-40% flowering
- 70-80% flowering

- Clementine varieties >300 flowers
- Orange varieties >150 flowers



Sampling ground cover

Each sample: 2 g of flowers from the four more abundant species in the orchard

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OBJECTIVE 2

IPM citrus and apple growing areas

Pesticide residues in bees and pollen collected by bees

IPM citrus and apple growing areas. Pesticide residues in bees and pollen collected by bees

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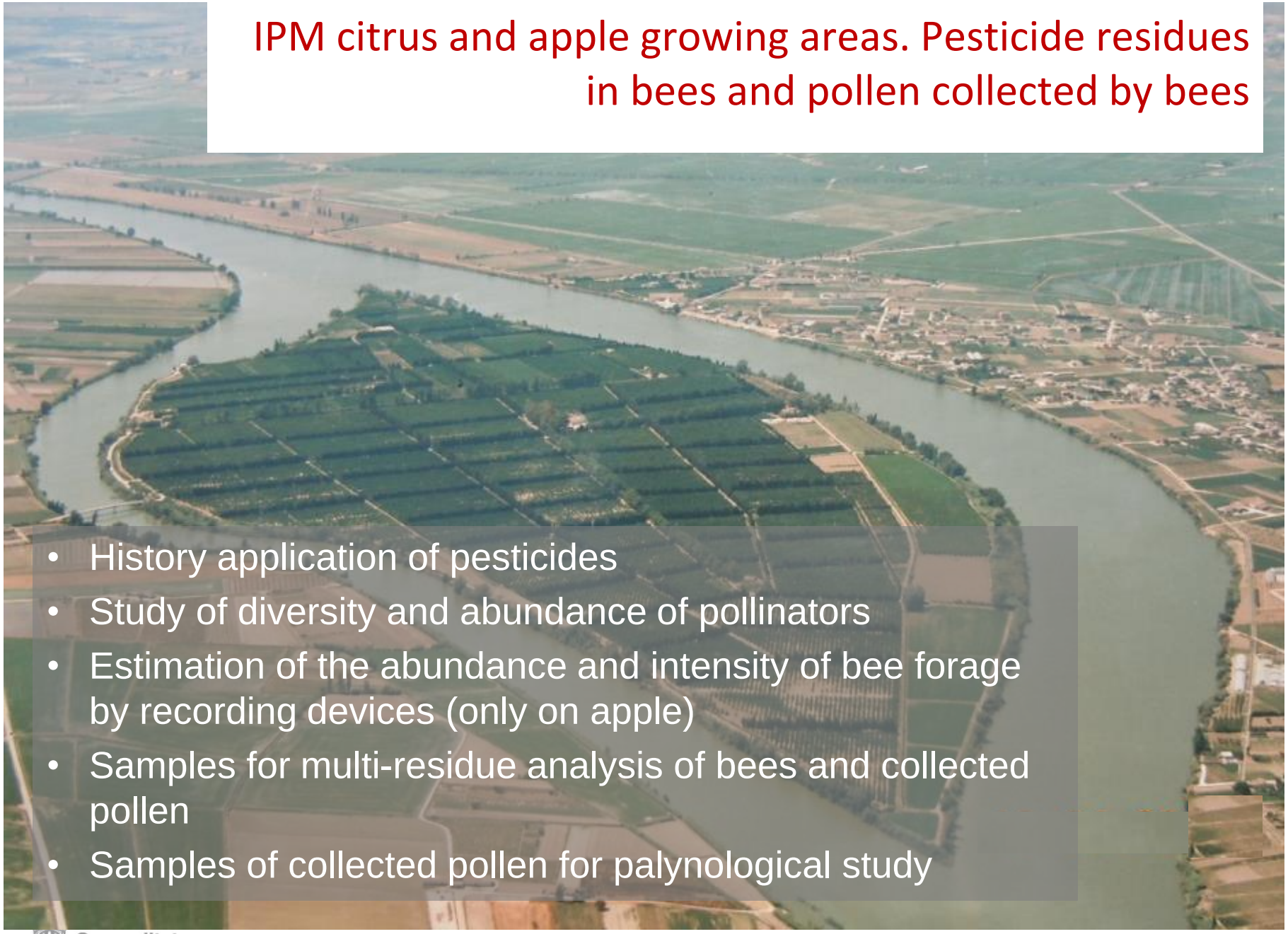


- History application of pesticides
- Study of diversity and abundance of pollinators
- Estimation of the abundance and intensity of bee forage by recording devices (only on apple)
- Samples for multi-residue analysis of bees and collected pollen
- Samples of collected pollen for palynological study

Integrated Pest Management areas

Orchard	Fruit tree	Location	Area
Cortal Gran	Apple	Sant Pere pescador	20 ha
Mas Badia	Apple	Canet de la Tallada	20 ha
Albanyà	Apple	Sant Miquel de Fluvià	20 ha
Mas Climent	Forest	Sant Martí Vell	10 ha
Illa	Citrus	S. Jaume d'Enveja (Tarragona)	85 ha
Ruben	Citrus	Vinaròs (Castellón)	20 ha
Viveros	Citrus	S. Rafel del Río (Castellón)	60 ha

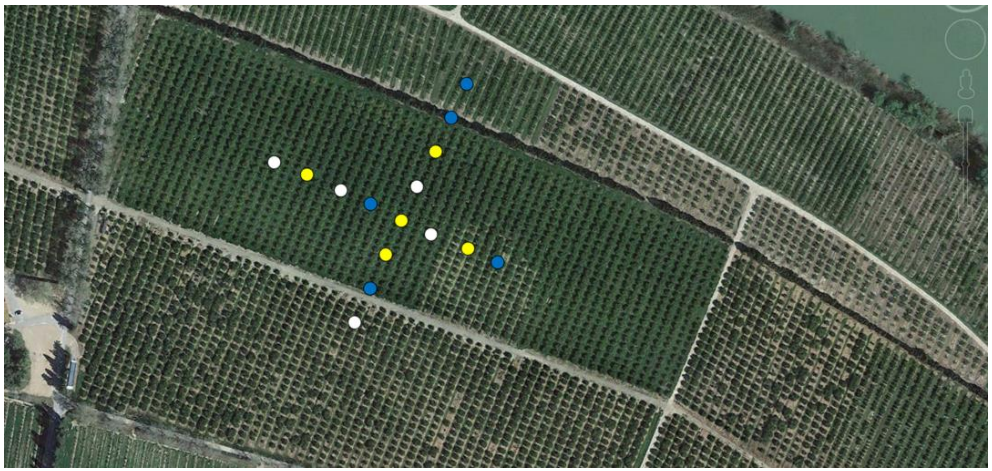
Pesticides applied

Fecha	Plaga	l/ha	Producto (m.a)	Concentración (%)
6/06/2015	Piojo rojo de California	3000	Dursban (Syngenta) **Clorpirifos** 44,6% p/p (EC)	0,02
			Alazin (Tradecorp) **Piriproxifen** 10% p/v (EC)	0,075
	Araña roja		Zeldox (Syngenta) **Hexitiazox** 10 % p/p (WP)	0,02
15/07/2015	Araña roja	3000	Vertimec (Syngenta) **Abamectina** 1,8% p/v	0,04
			Zeldox (Syngenta) **Hexitiazox** 10 % p/p (WP)	0,02
25/08/2015	Araña roja	3000	Vertimec (Syngenta) **Abamectina** 1,8% p/v	0,04
			Zeldox (Syngenta) **Hexitiazox** 10 % p/p (WP)	0,02
			Oil oro (Q Oro) **Aceite de parafina** 83% p/v. (EC)	1,5

Diversity and abundance of pollinators in citrus and apple

a) Pan traps

15 traps per orchard during 24 hours (5 of each ultraviolet bright color: white, blue and yellow) located along two perpendicular transects during bloom and one month later (LeBuhn et al, 2003)



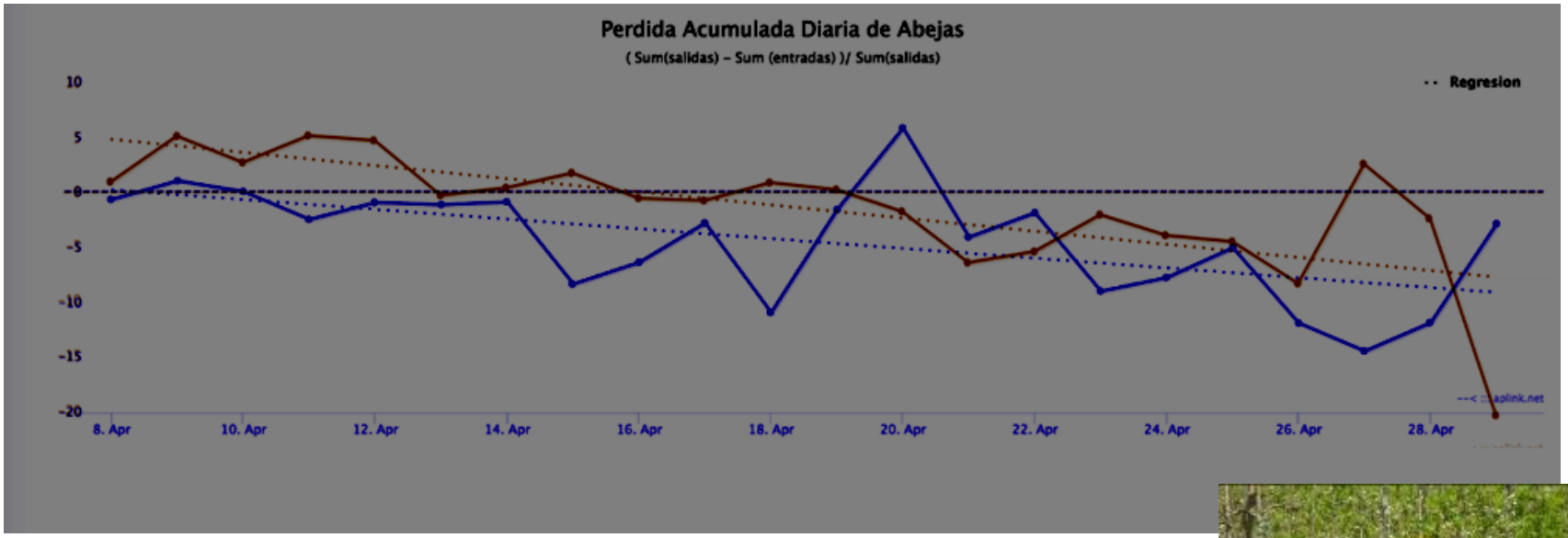
Diversity and abundance of pollinators in citrus and apple

b) Nest traps

Five traps per orchard consisted in 100 internodes of cane Ø= 6-12 mm; L= 25 cm. (Morón et al, 2012)

Estimation of the abundance and intensity of foraging by bees recording devices (apple)

- April, during apple bloom
- Bee recording devices in apple orchards and in the forest



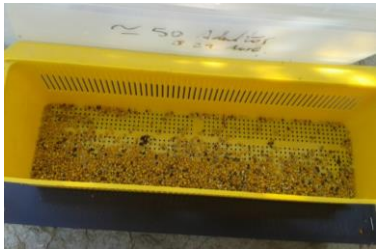
Samples of bees and collected pollen for multi-residue analysis
Samples of pollen for palynological study



Three beehives/area

Three samples per beehive:

- 10% flowering
- 30-40% flowering
- 70-80% flowering



4 g of pollen

50 honeybees

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OBJECTIVE 3

Semi field studies under mesh cages

Neonicotinoids residues in pollen of apple and citrus flowers, bees and wax

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APPLE

3 mesh cages 300 m^2

CITRUS

18 mesh cages 16 m^2

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APPLE

Imi	C	Imi

- Imidacloprid foliar sprays in two cages in pre-flowering (one control cage)
- At the beginning of bloom, cores bees were located inside the cages

Samples:

- 50 bees/cage and wax at the beginning and at the end of flowering
- Pollen at 70% flowering (3 samples per cage)

CITRUS

Imidacloprid 1	Imidacloprid 2	Imidacloprid 3	4	Imidacloprid 5	6	7	Control 8	Control 9

Control 18	Control 17	16	Tiametoxam 15	Tiametoxam 14	Tiametoxam 13	12	Tiametoxam 11	10

- Imidacloprid and Tiametoxam foliar sprays in pre-flowering
- At the beginning of bloom, mini-hives *Bombus terrestris* located inside the cages

Samples:

- All individuals *Bombus* dead and alive inside the cages were counted
- 60 dead and 60 alive *Bombus* per cage
- Pollen from flowers from each cage

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