# Exclusion nets: a step towards pesticide-free apple growing in North America

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# Growing organic apples is difficult in NE North America…

| | |
|---|---|
| *Blastodacna atra* | Apple pith moth |
| *Lyonetia speculella* | Apple leafminers |
| *Rhagoletis pomonella* | Apple maggot |
| *Orthosia hibisci* | Speckled green fruit worm |
| *Grapholita prunivora* | Lesser appleworm |
| *Phytoptus pyri* | Pear leaf blister mite |
| *Phyllobius* sp. | Leaf weevils |
| *Spilonota ocellana* | Eyespotted bud moth |
| *Coleophora* sp. | Cigar and Pistol casebearers |
| *Cacopsylla mali* | Apple sucker |
| *Aphis spiraecola (citricola)* | Spirea aphid |
| *Rhopalosiphum fitchii* | Apple grain aphid |
| *Eriosoma lanigerum* | Woolly apple aphid |
| *Dysaphis plantaginea* | Rosy apple aphid |
| *Aphis pomi* | Green apple aphid |
| *Euschistus* sp | Brown stink bugs |
| *Campylomma verbasci* | Mullein bug |
| *Lygocoris communis* | Green apple bug |
| *Heterocordylus malinus* | Hawthorn dark bug |
| *Lygus lineolaris* | Tarnished plant bug |
| *Acrosternum* sp. | Green stink bugs |
| *Ostrinia nubilalis* | European corn borer |
| *Saperda candida* | Roundheaded apple tree borer |
| *Popillia japonica* | Japanese beetle |
| *Macrodactylus subspinosus* *Scolytus rugulosus* | Rose chaferScolyte des arbres Shothole borer |
| *Synanthedon scitula* | Dogwood borer |
| *Lymantria dispar* | Gypsy moth |
| *Psorosina* sp. et *Choreutis* sp. | Skeletonizers |
| *Ctenicera* sp. , *Agriotes* sp. | Click beetles |
| *Ametastegia glabrata* | Dock sawfly |
| *Tetranychus urticæ* | Twospotted spider mite |
| *Panonychus ulmi* | European red mite |
| *Tæniothrips inconsequens* | Pear thrips |
| *Choristoneura rosaceana* | Obliquebanded leafroller |
| *Argyrotænia velutinana* | Redbanded leafroller |
| *Platynota idæusalis* | Tufted apple bud moth |
| *Archips argyrospila* | Fruittree leafroller |
| *Grapholita molesta* | Oriental fruit moth |
| *Pseudexentera mali* | Pale apple leafroller |

| | |
|---|---|
| *Alternaria alternata* | Alternaria fruit rot |
| *Alternaria mali* | Alternaria blotch |
| *Alternaria* sp., *Cladosporium* sp., *Epicoccum* sp. et autres | Moldy core, core rot |
| *Podosphæra leucotricha* | Powdery mildew |
| Phytoplasme probable du groupe 16SrIII-B | Apple rubbery wood ou ARW |
| *Erwinia amylovora* | Fire blight |
| *Nectria galligena* | European canker |
| *Botryosphæria obtusa* | Black rot (Blossom end rot, Frogeye leaf spot) |
| *Candidatus Phytoplasma pyri* (16SrX-C) | Pear decline ou PD |
| *Nectria cinnabarina* | Nectria twig blight |
| Phytoplasme du groupe 16SrI | Aster yellows ou AY |
| *Chondrostereum purpureum* | Silver leaf |
| *Schizothyrium jamaicensis* | |
| *Sclerotinia sclerotiorum*, | |
| *Botrytis cinerea* | |
| *Phytophthora cactorum* | |
| *Physalospora obtusa* | |
| *Gloeodes pomigena* | |
| *Physalospora obtusa* | |
| *Venturia inæqualis* | |
| *Agrobacterium tumefaciens* | |
| *Armillaria mellea* | |
| *Pezicula malicorticis* | |
| *Nectria galligena* | |
| *Helminthosporium papulosum* | |
| *Gymnosporangium juniperi-virg* | |
| *Gymnosporangium clavipes* | |
| *Gymnosporangium globosum* | |
| *Colletotrichum acutatum* | |
| *Colletotrichum gloeosporioides* | Glomerella |
| *Botryosphaeria dothidea* | White rot |
| *Schizothyrium pomi* | Flyspeck |
| *Peltaster fructicola* | Sooty blotch |
| *Leptodontium elatius* | Sooty blotch |

| | |
|---|---|
| *Paleacrita vernata* | Springcankerworm |
| *Alsophila pometaria* | Fall cankerworm |
| *Erannis tiliaria* | *Linden looper* |
| *Chrysobothris femorata* | Flatheaded appletree borer |
| *Cydia pomonella* | Codling moth |
| *Dasineura mali* | Apple leaf(curling) midge |
| *Stictocephala bubalus* | Buffalo treehopper |
| *Torymus varians* | Apple seed chalcid |
| *Tachypterellus quadrigibbus* | Apple curculio |
| *Conotrachelus nenuphar* | Plum curculio |
| *Polydrusus impressifrons* | Pale green weevil |
| *Schizura concinna* | Redhumped caterpillar |
| *Typhlocyba pomaria* | White apple leafhopper |
| *Empoasca fabæ* | Potato leafhopper |
| *Pseudoccus comstocki* | Comstock mealybug |
| *...idiotus perniciosus* | San Jose scale |
| | ...ean fruit scale |

| Nom latin | Nom anglais |
|---|---|
| *Geastrumia polystigmatis* | Sooty blotch |
| *Penicillium expansum* | Blue mold |
| *Mucor piriformis* | Mucor rot |

| Nom latin | Nom anglais |
|---|---|
| *Microtus pennsylvanicus pennsylvanicus* | Meadow vole, Field mouse |
| *Odocoileus virginianus* | White-tailed deer |
| *Sylvilagus floridanus* | Eastern cottontail |
| *Lepus americanus* | Snowshoe hare |
| *Marmota monax* | Woodchuck (Groundhog) |
| *Erethizon dorsatum* | American porcupine |

| Agent causal | Nom anglais |
|---|---|
| ApMV | Apple mosaic virus |
| TmRSV /ToRSV | Apple union necrosis and decline virus |
| ACLSV | Apple chlorotic leaf spot virus |
| ASGV | Apple stem grooving virus |
| ASPV | Apple stem pitting virus |

| Nom latin | Nom anglais |
|---|---|
| *Corvus brachyrhynchos* | American crow |
| *Meleagris gallopavo* | Wild turkey |
| *Pinicola enucleator* | Pine grosbeak |
| *Sturnus vulgaris* | European starling |
| *Bonasa umbellus* | Ruffed grouse |
| *Pratylenchus* sp. | Root lesion nematodes |

*Chouinard et al. 2018*

# But how about growing *without pesticides*?

- If key pests can be controlled
- If diseases do not flare up
- If climate extremes are not too challenging
- If pollination can be achieved

# Exclusion systems exist for tree fruit

Chouinard

lfl.bayern.de

Severac

Charlot

Lefsrud

www.irda.qc.ca

# 7-yr study 2012-2018

- Assess the effectiveness of a *complete* exclusion system for the prevention of apple fruit damage
  - Without using any pesticide or other sprays
  - On a ‘Honeycrisp’ high-density planting
  - Exclusion nets in place from bud-break to harvest
- Improve our knowledge of :
  - Primary and secondary pests and diseases, non-parasitic disorders
  - Photosynthesis and fruit quality
  - Pollination within / below nets
  - Nets and structure : strength, durability, ease of opening

# Setup

- Cv. Honeycrisp / B9 (planted 2006)
- Zero sprays (no pesticides, growth regulators, fertilizers)
- Each plot: 10 m (12 trees)
- Compared treatments (6X):
  1) nets*
  2) No nets

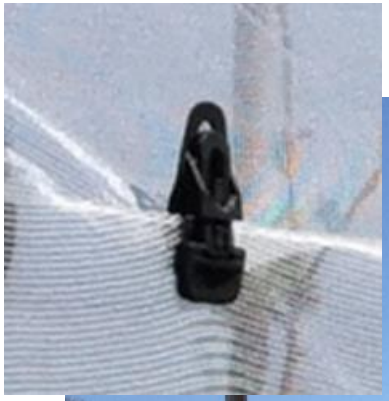
*ProtekNet 60g/m clear HDPE
  - mesh: 0,95x1,9mm
  - light transmission: 93%

Aerial photo of some rows

# Collected data

- Fruit damage (insects, diseases and non-parasitic)
- Foliar pests populations
- Temperature and photosynthesis
- Fruit load and quality (color, size, firmness, sugars, etc.)

# Installation - spring



# Complete exclusion

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# Opening (for summer work)

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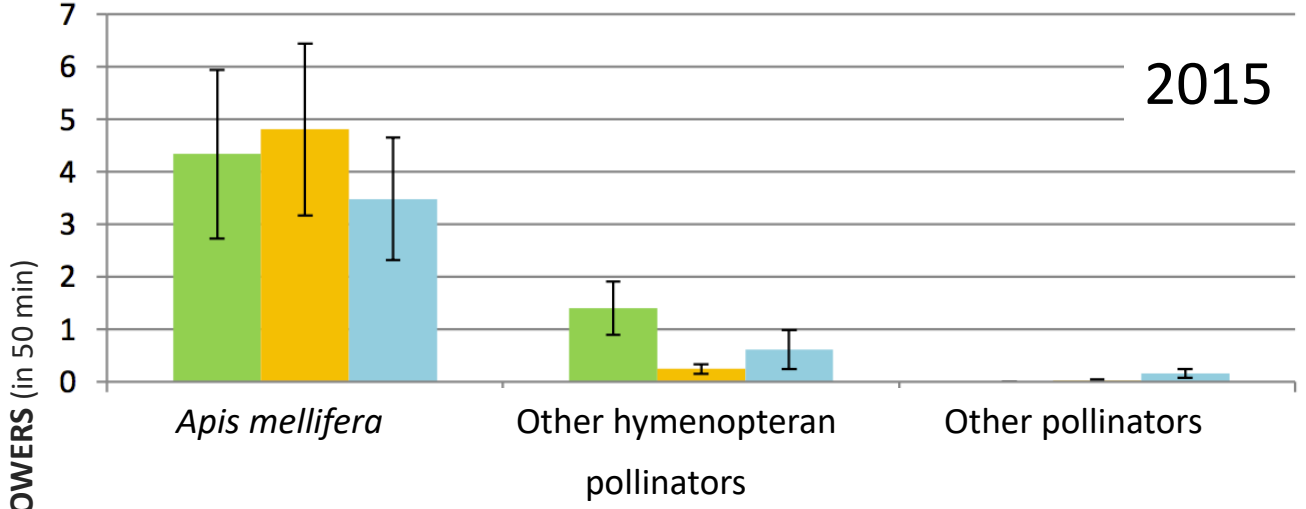
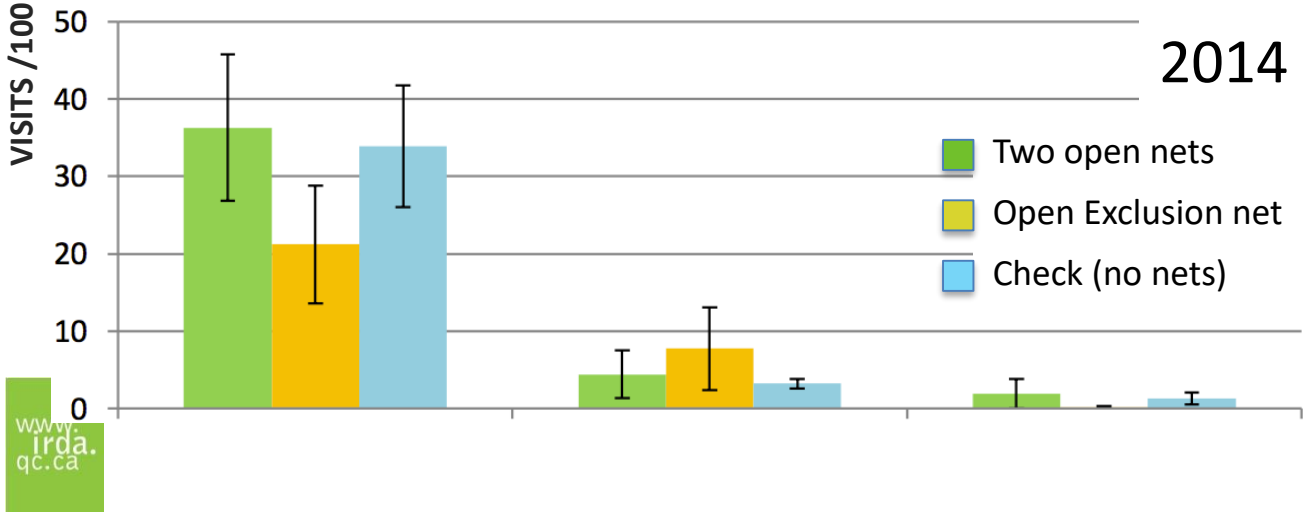
# Opening (for pollination)

# Visited flowers

- Opened nets do not affect pollination behavior



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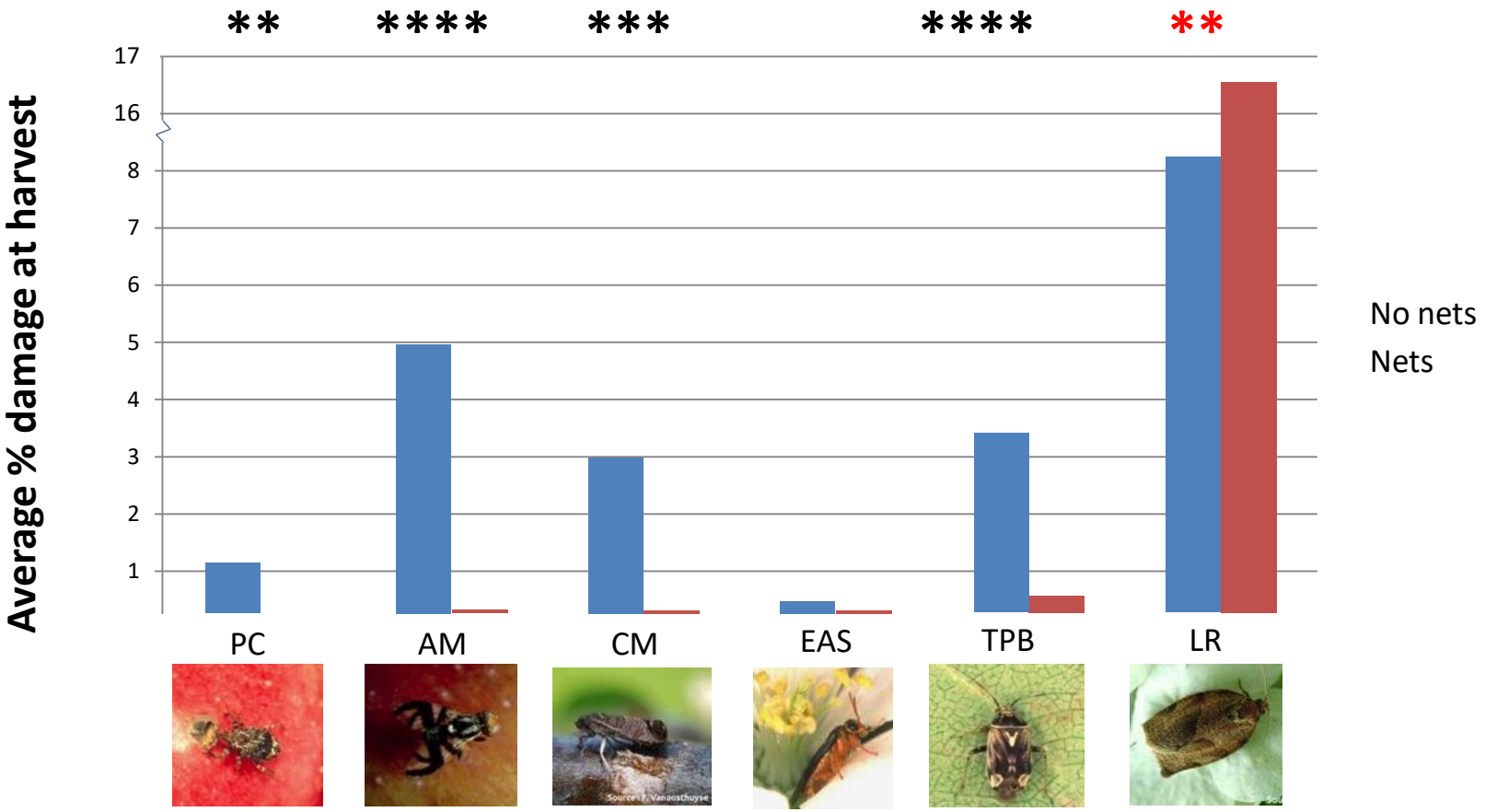
# Fruit pests (2012-2016)

(120 apples/unit, picked < 1 week from harvest)




*Chouinard et al. 2017. Crop Protection 98:248*

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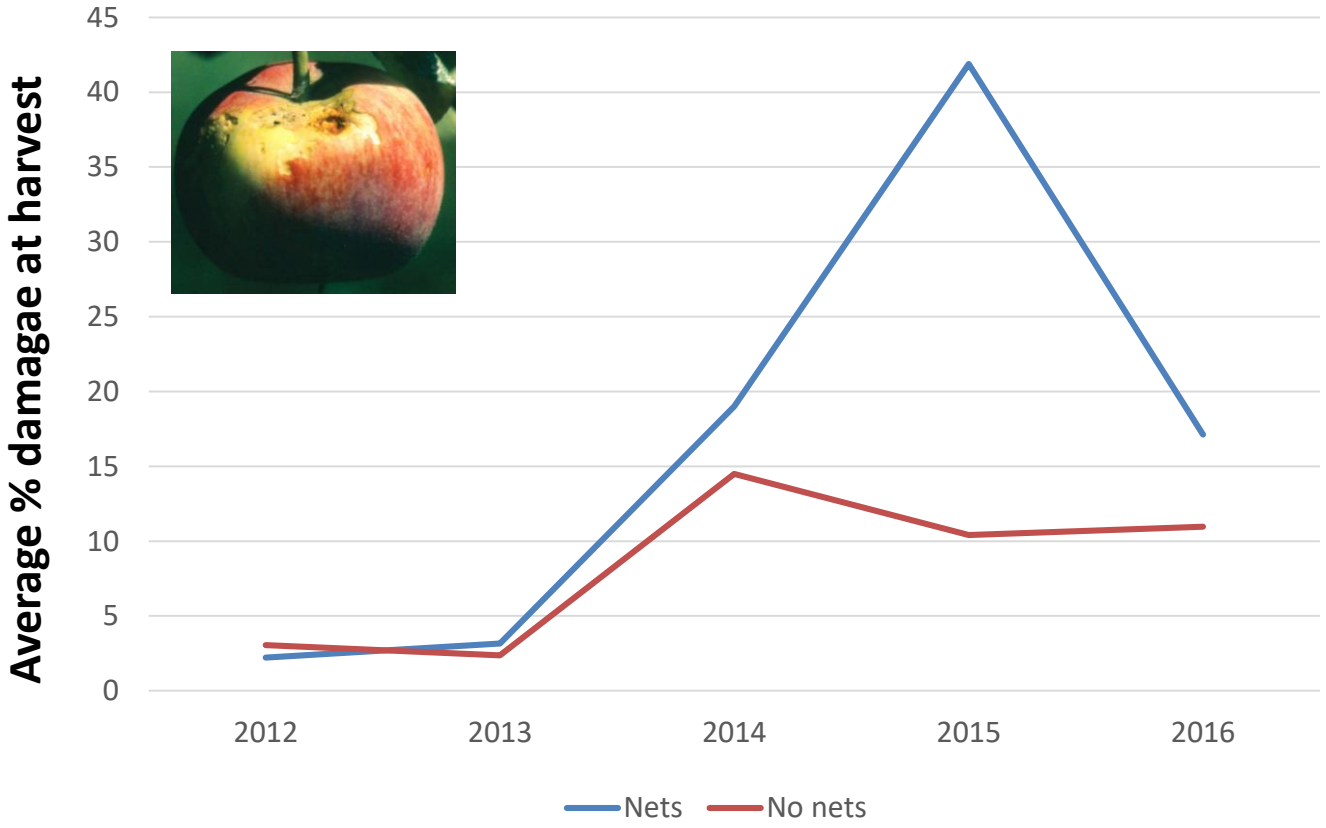
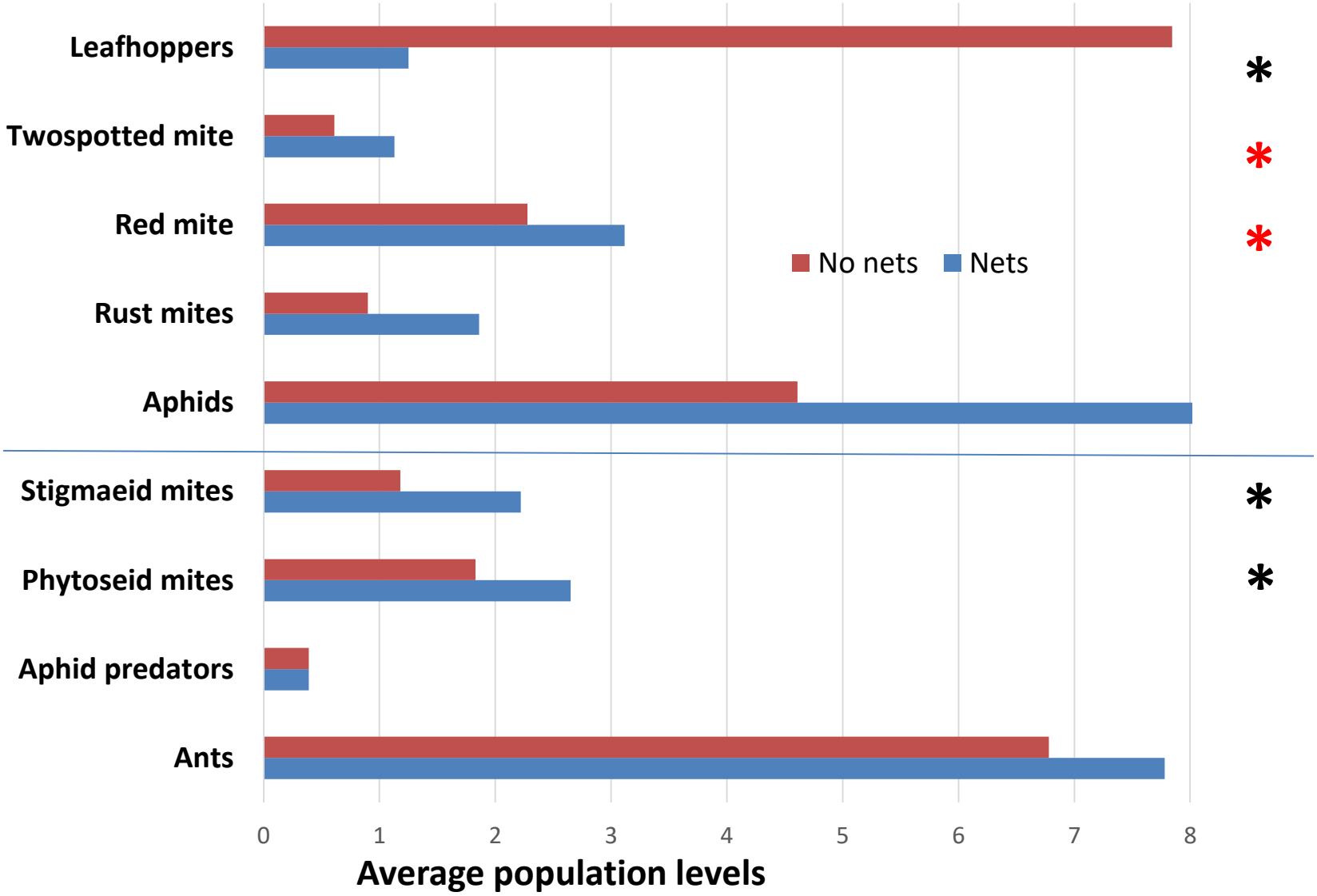
# Leafroller damage – 2012-2016

*(Choristoneura rosaceana*, Obliquebanded leafroller)



# Summer arthropods (2012-13-16)

(various population indices, pests and beneficials)

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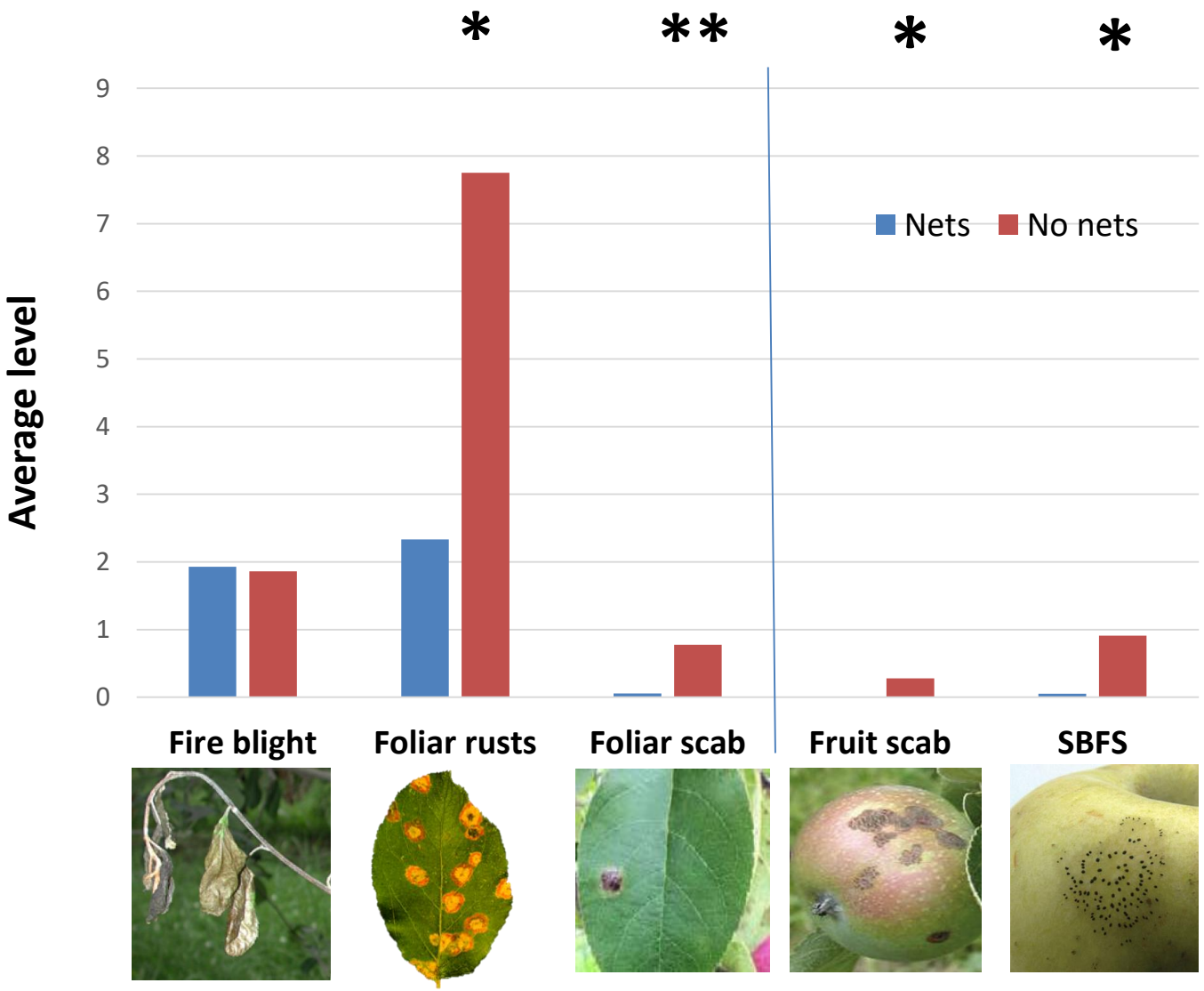
# Fruit and foliar diseases (3-5 years)

(various indices)

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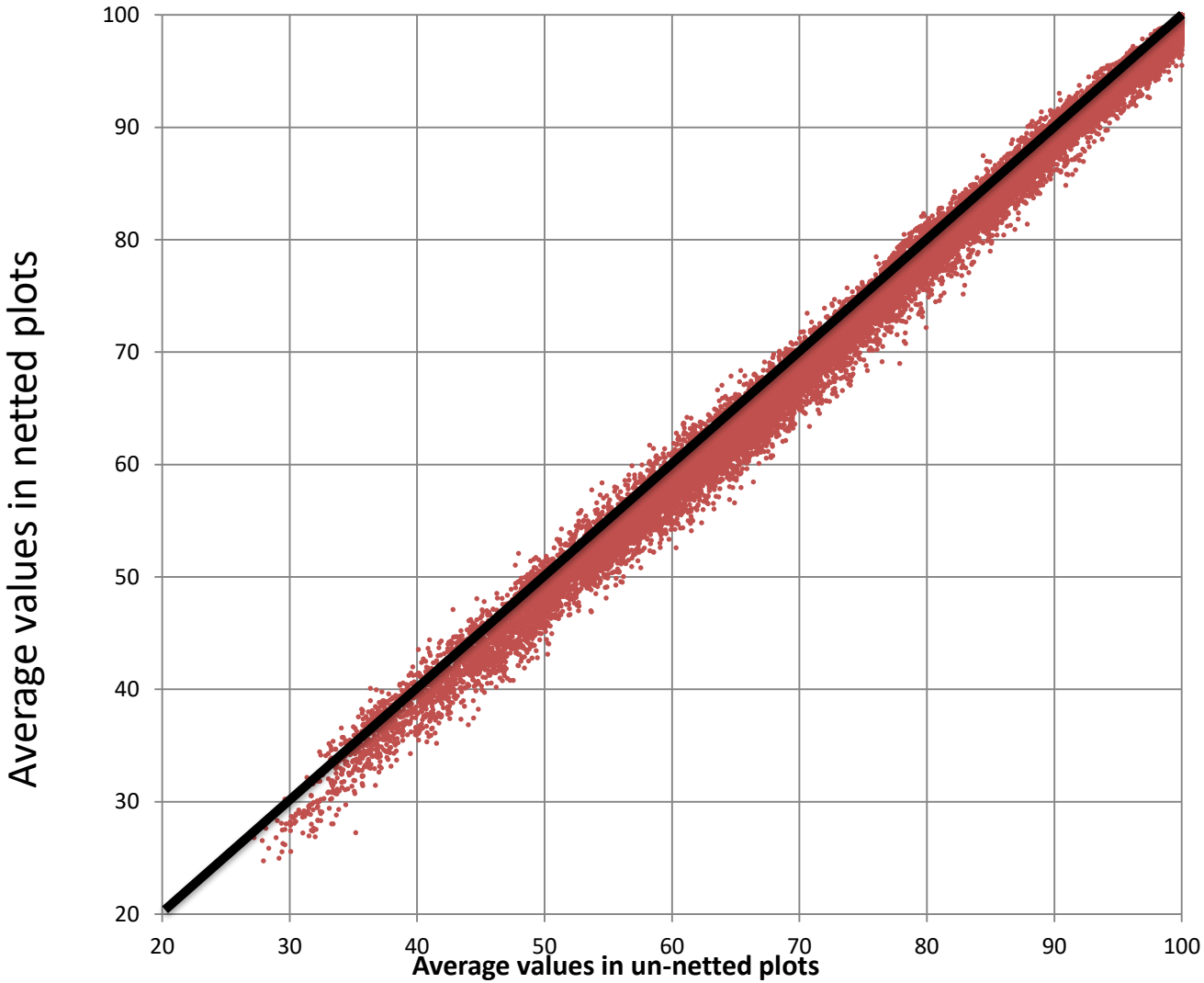
# Relative humidity– May-August




2015, 1 dot=
5-min average

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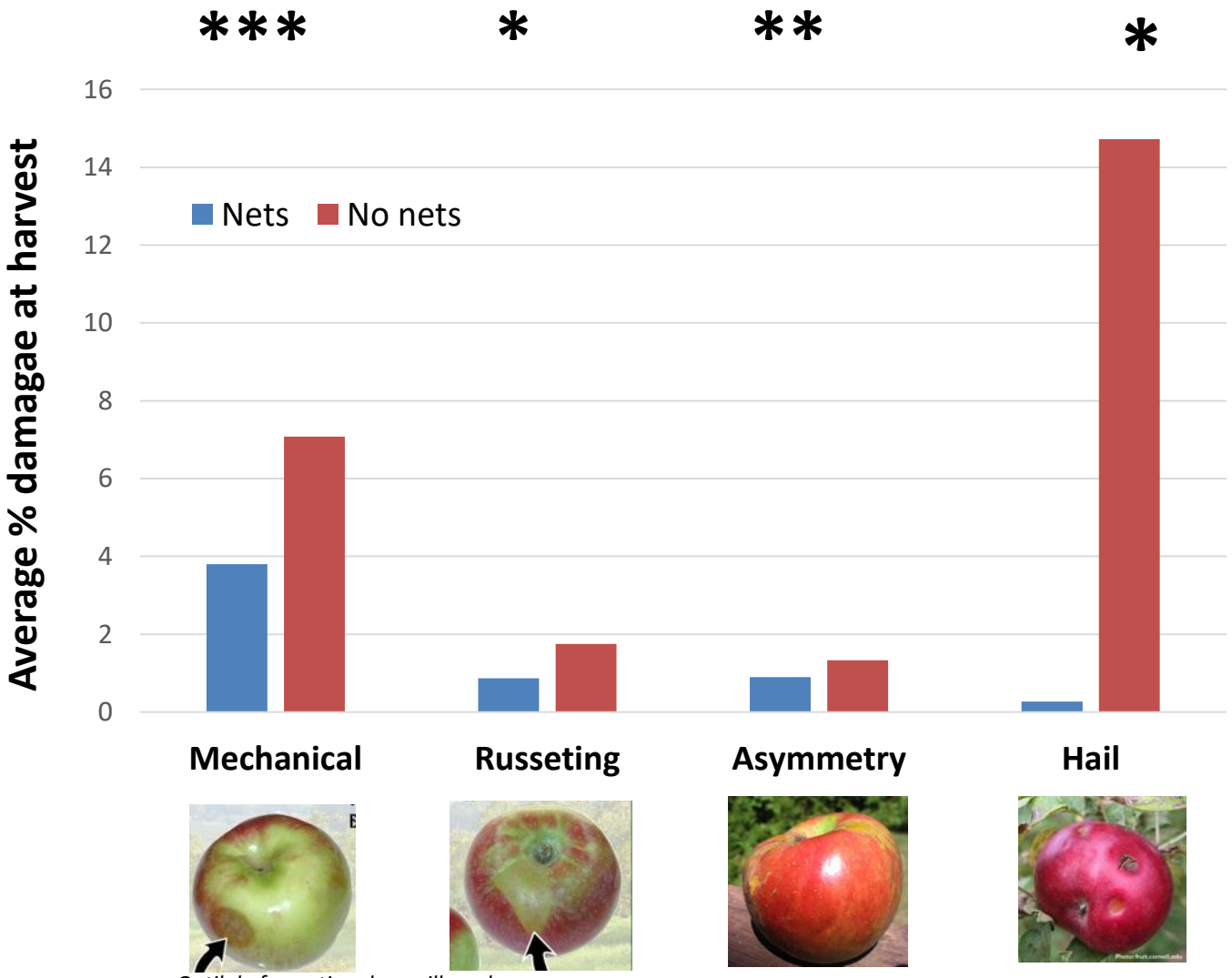
# Non-parasitic damage (2012-2016)

(120 apples/unit, picked < 1 week prior to harvest)



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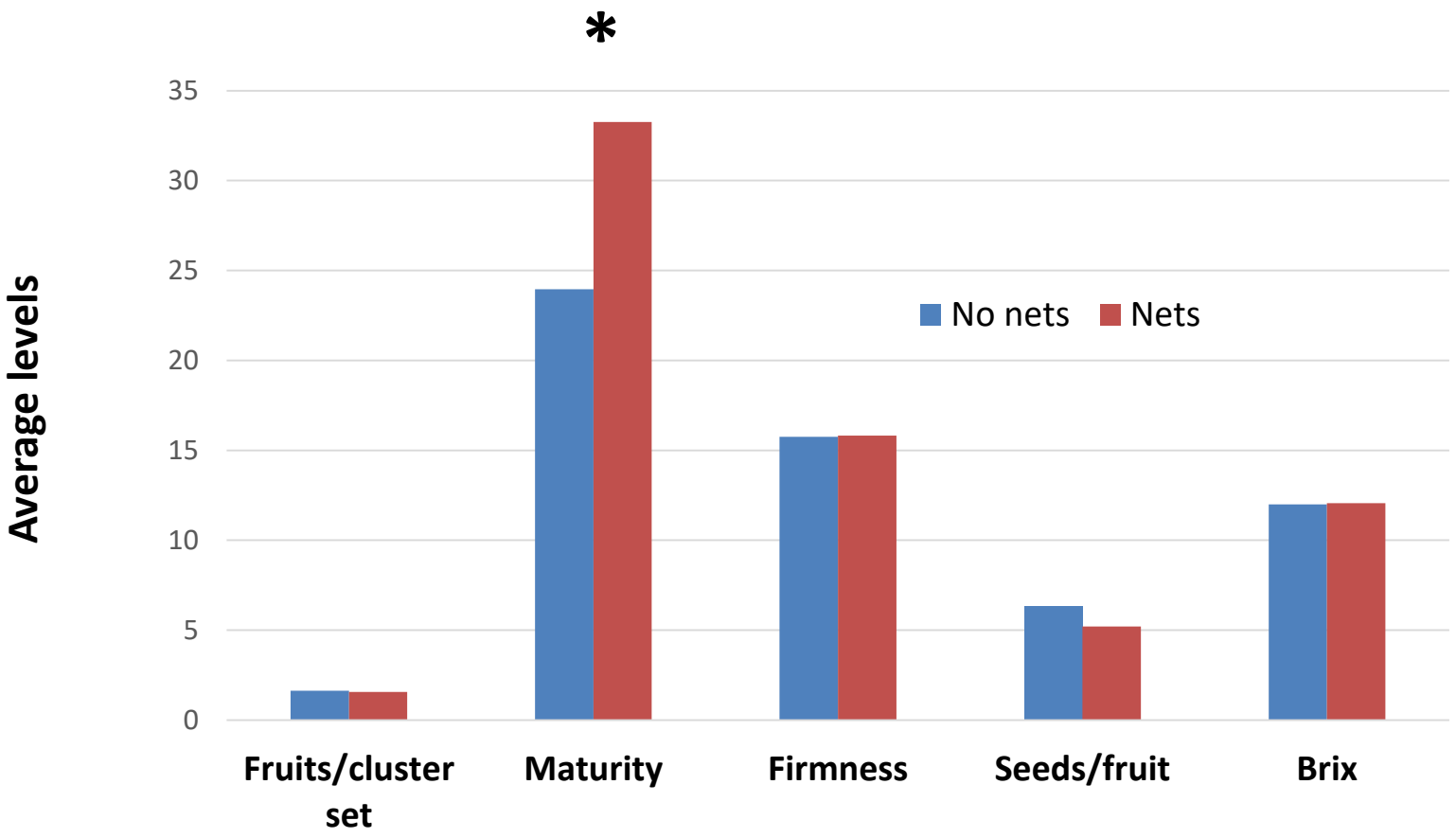
# Photosynthesis and fruit quality (3-5 years)

(various indices)

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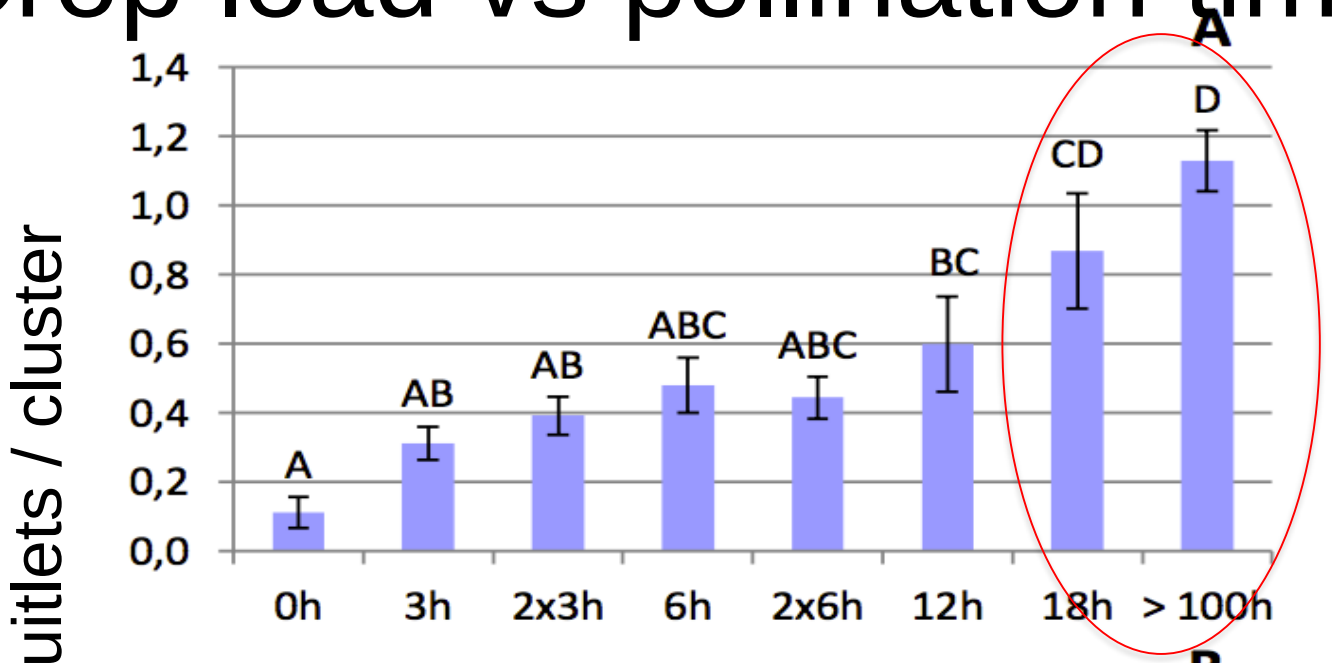
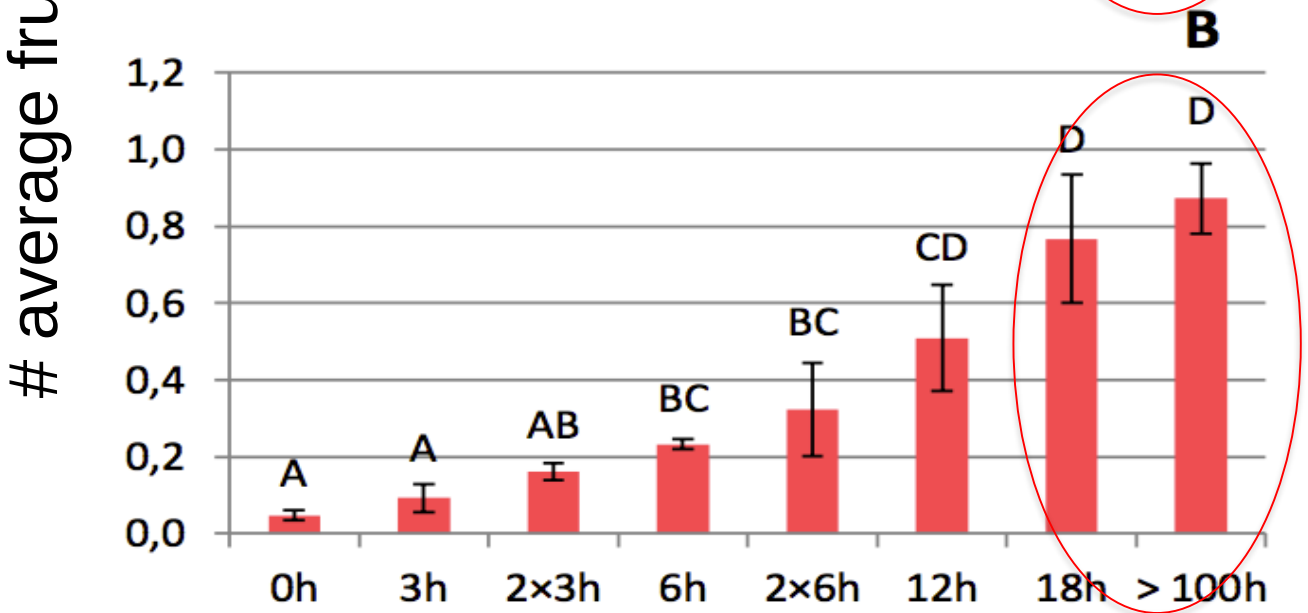
# Crop load vs pollination time




2015




2014

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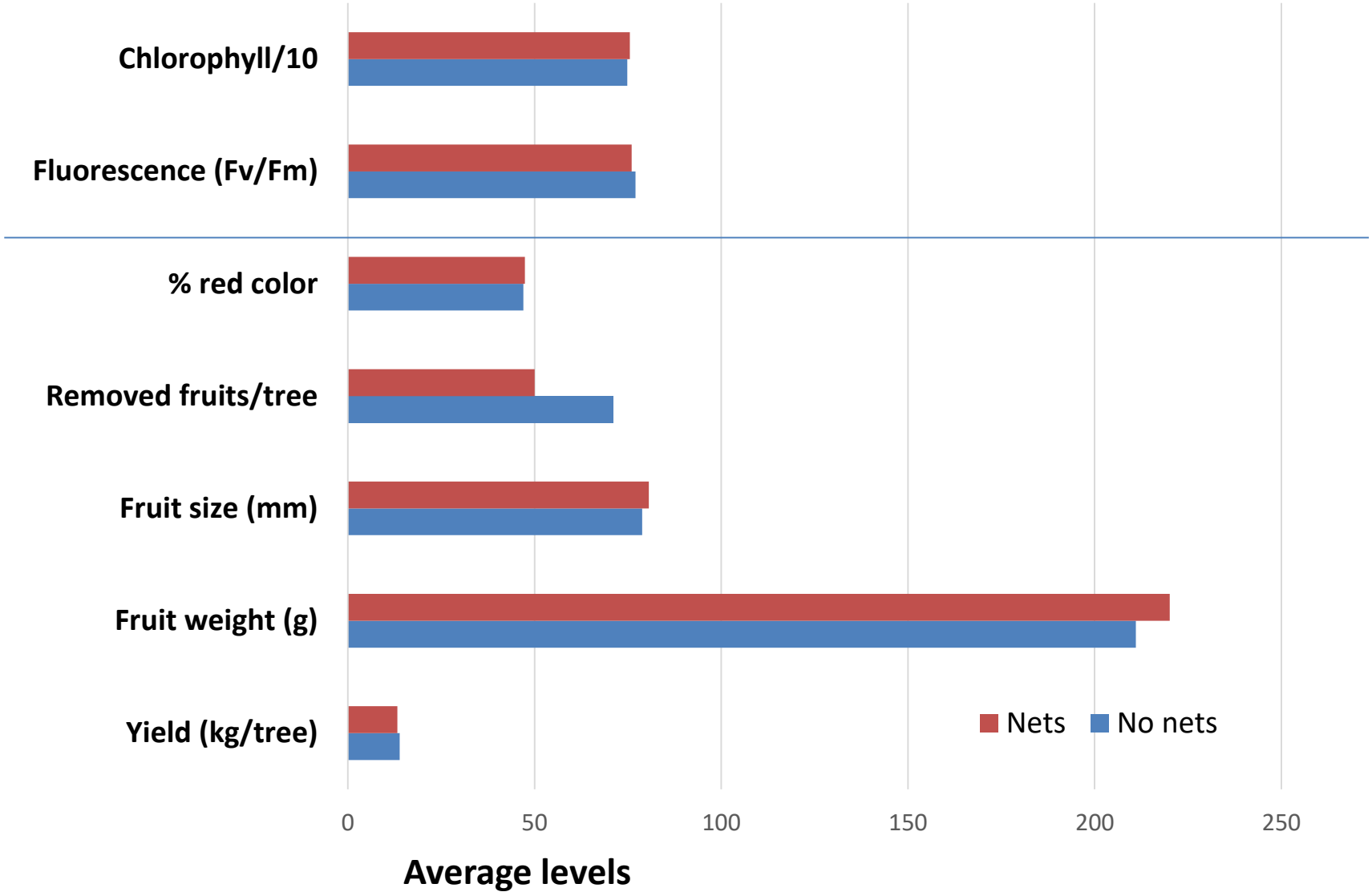
# Photosynthesis and fruit quality (3-5 years)

(various indices)

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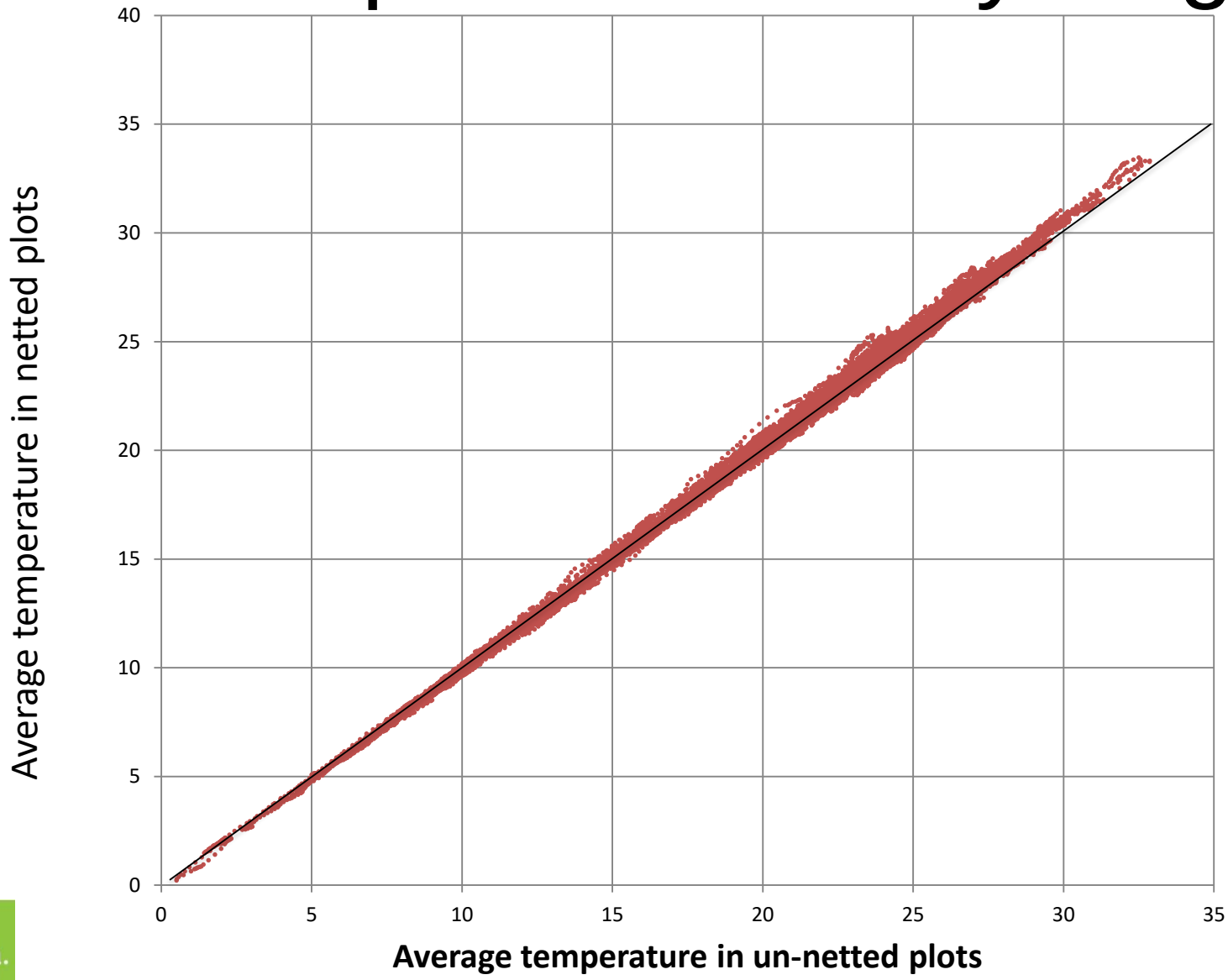
# Air temperature – May-August




2015, 1 dot=
5-min average

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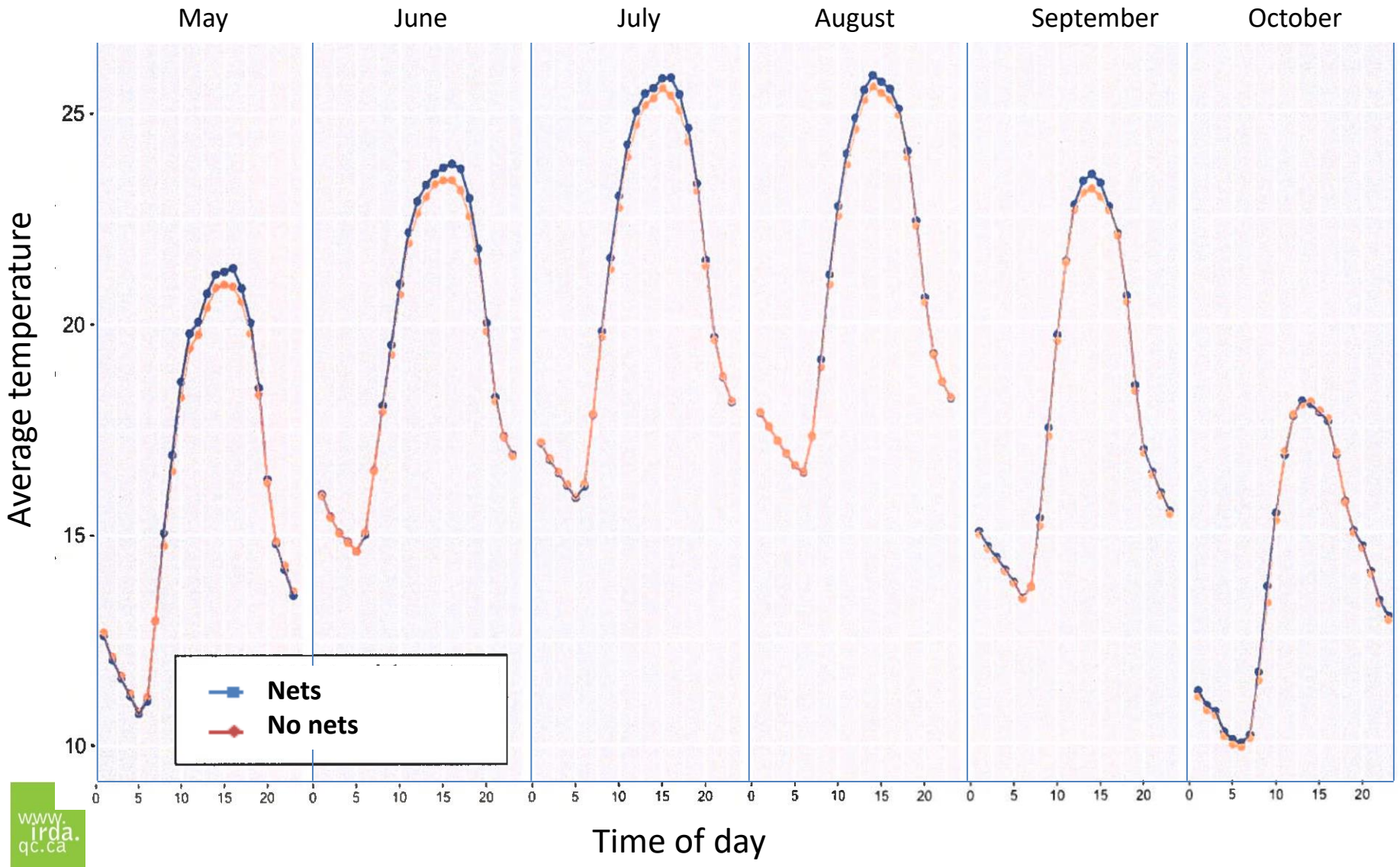
# Air temperature – May-August

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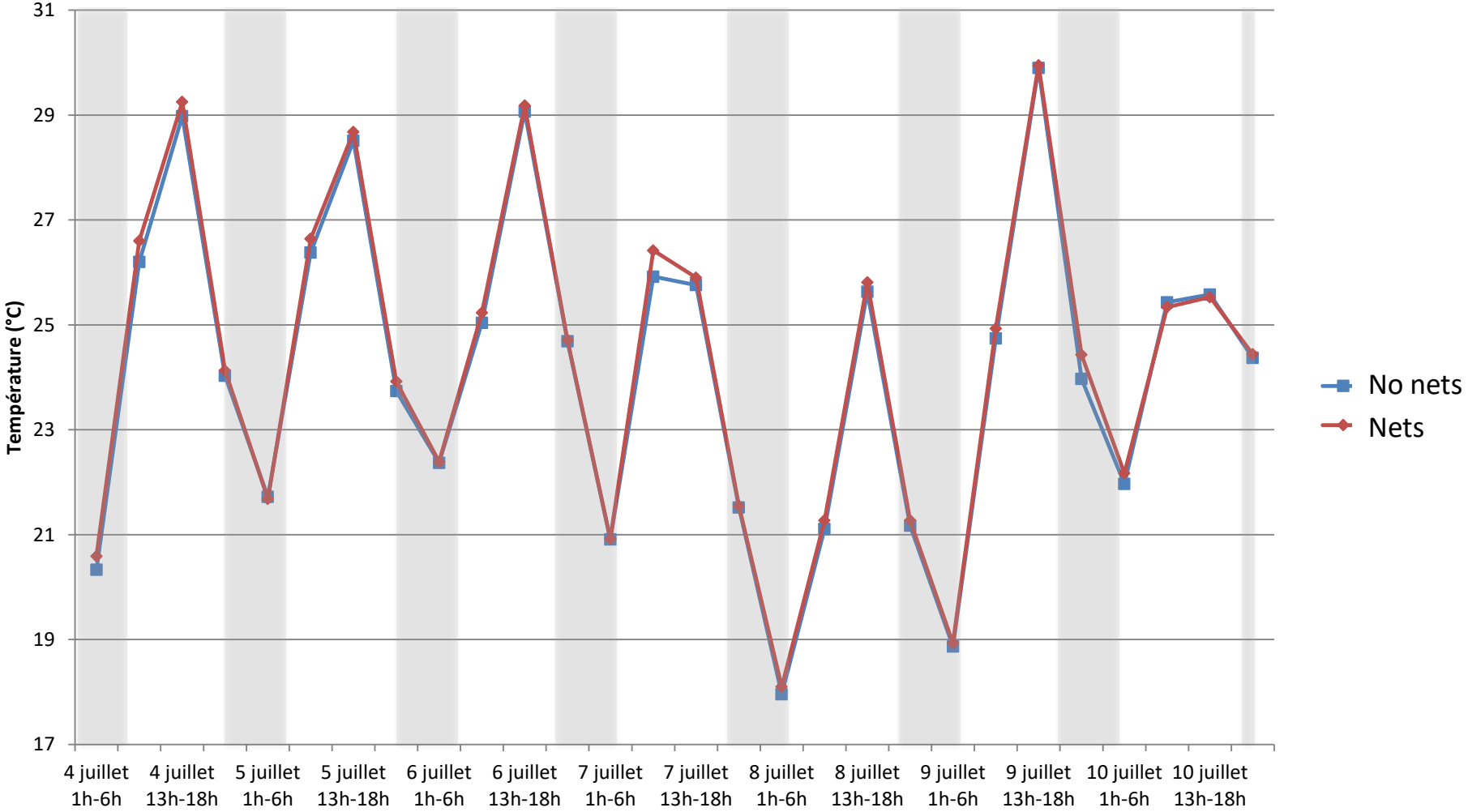
# Air temperature - July




2013, 1 dot= 6-h average

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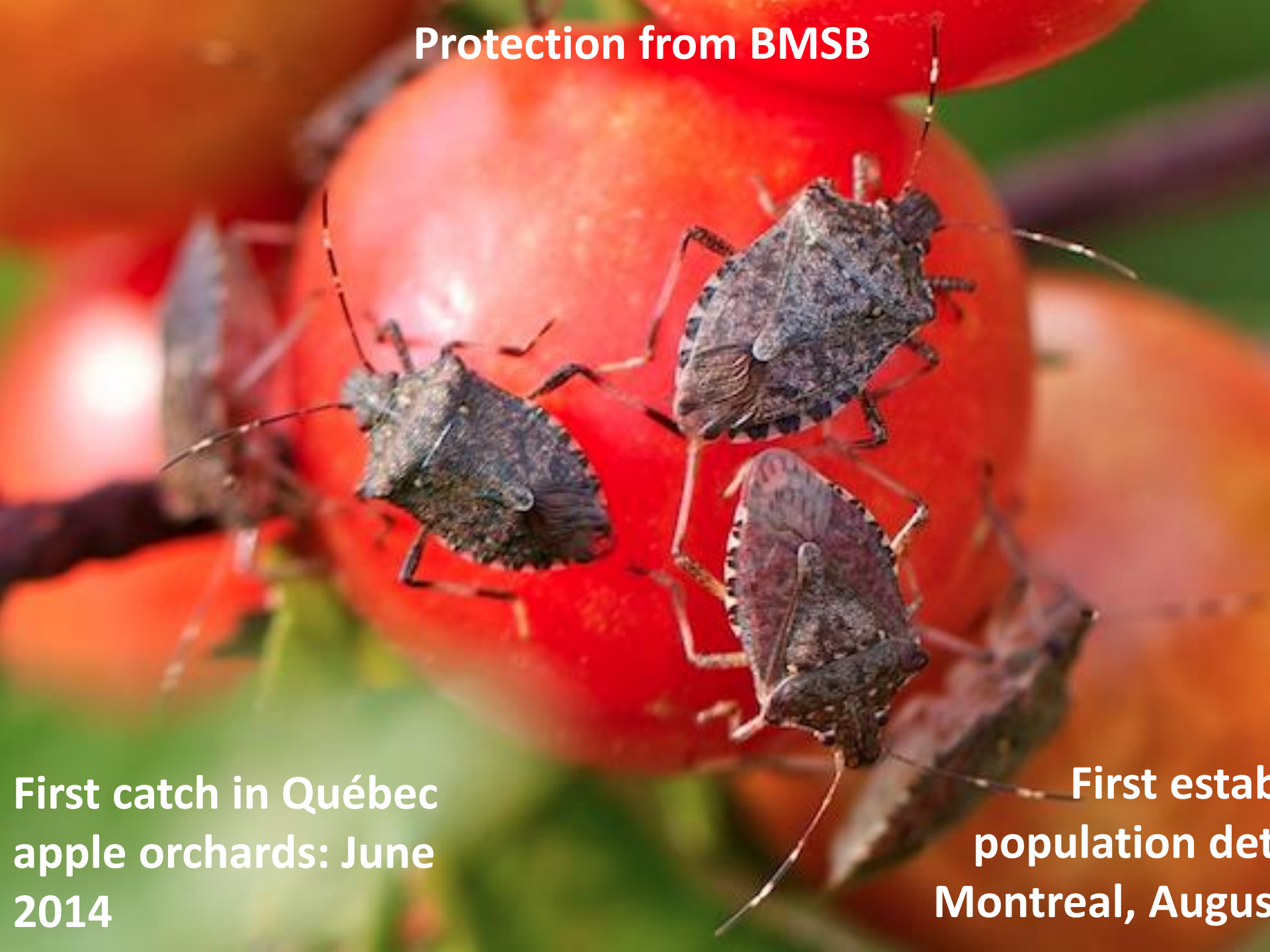
# Seven years of pesticide-free Honeycrisp :

- Requires investment (11$/m/10yr)
- Requires additional labour for pollination (0,60$/m/open day)
- Complicates thinning / other sprays
- Protects fruit from insects - except for OBLR
- Protects from birds / mammals
- Protects from mechnical injuries and hail
- Does not result in scab epidemic
- Does not significantly affect tree physiology
- Produces high-quality fruit
- May slow down fruit maturity by up to ca. 1 wk

# Protection from BMSB



First catch in Québec apple orchards: June 2014

First estab
population det
Montreal, Augus

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- **Organisationnal support:**
  - IRDA - Quebec Apple Network
  - CETAB +
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  - Polytechnique Montreal
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  - Innov'action (MAPAQ)
  - Québec Apple Growers
  - Dubois Agrinovation (nets)

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