Beneficial insects and control of crop pests

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Beneficial Insects

• What makes an insect beneficial?
Beneficial Insects

• What makes an insect beneficial?
  – its “benefit” to humans

• Predators
• Parasitoids
• Pollinators
Beneficial Insects

Parasitoid: “beneficial”
*Aphidius avenaphis* stings a red morph *Sitobion avenae*

Parasitoid: not “beneficial”
*Pteromalus venustus* kills alfalfa leafcutter bees

Instead of a ladybug, get a ladybug killing wasp: *Dinocampus coccinellae*
Sampling techniques

1. Transects: whole plant counts

2. Trapping with sticky cards or traps.

3. Sweep netting
PREDATORS

Eat “pest” insects.
Chewing or sucking…but the end result is the same…one dead insect pest.
Insect composition: year and location differences

Ex. Beneficial insect web: Aphid predator web (Manitoba)

English grain aphid (*Sitobion avenae*)

Parasitism
Aphid mummies/total aphids = ~ 1%

Damsel bug* (*Nabis americoferus*)

Lacewing larvae (*Chrysoperla carnea*)

*Orius tristicolor* adult

Greenbug aphid (*Schizaphis ggraminum*)

2012-2013

Bird cherry oat aphid (*Rhopalosiphum padi*)

2013

2012-2013 2013

Insect composition: year and location differences
Ex. Beneficial insect web: Saskatchewan English Grain Aphid predator web

2012-2013

English grain aphid (Sitobion avenae)

Parasitism
Aphid mummies/total aphids = 7.6%

Green lacewing adult

Green lacewing larvae
Chrysoperla carnea and Crysopa oculata

Coccinella septempunctata adult
Hippodamia tredecimpunctata

2013

Bird cherry oat aphid (Rhopalosiphum padi)

Coccinella septempunctata larvae
Hippodamia tredecimpunctata

No damsel bugs and no Minute pirate bugs in the Saskatchewan survey, + higher parasitism…
Lady beetles, bugs, birds (Coleoptera: Coccinellidae)

**Adults**

13 spotted *Hippodamia tredecimpunctata* L.

7 spotted *Coccinella septempunctata* L.

**Larvae**

Both adults and larval lady beetles are aphid predators
Predatory insects

- Ladybug adults
- Generalist feeder...but prefers aphids

Ladybugs can be purchased online and released in greenhouses, yards etc.
Predatory insects

- Ladybug larva and pupa (below)
- Larva is a generalist feeder
- Pupa does not feed
Predatory insects

C7 larva vs. an English grain aphid
In the field...
Green lacewings (Neuroptera: Chrysopidae)

Larvae: (aphid lions)
*Chryoperla carnea* and *Chrysopa oculata*

*C. carnea*: common green lacewing

*C. oculata*: golden-eyed lacewing

Green lacewing larvae (aphid lions) are voracious aphid predators.
Green lacewings (Neuroptera: Chrysopidae)

- (aphid lions)

Green lacewing larvae (aphid lions) are voracious aphid predators.
Predatory insects

- Green lacewing larvae *Chrysoperla carnea* (left) and *C. oculata* (right) (Neuroptera)
- "Aphid lions"
- A generalist predator…but likes aphids
Green lacewings (Neuroptera: Chrysopidae)

• aphid lion attacking a ladybug larva

Green lacewing larvae (aphid lions) are voracious aphid predators AND are generalist predators.
Predatory insects

- Predatory ground beetles
Minute Pirate Bugs

**Orius tristicolor** (White)  
(Hemiptera: Anthocoridae)

- **Orius tristicolor** *
  - Minute pirate bug
  - Also in Eastern Canada, but often confused with *O. insidiosus* (same size, colour, habits and behaviour)
  - On the prairies we have *O. tristicolor* (clavus is all black)

See Kelton 1978 The Anthocoridae of Canada and Alaska
Damsel bug (Hemiptera: Nabidae)

- Damsel bug: Nabidae, most are *Nabis americoferus* on the Prairies.

Has slightly raptorial front legs like a praying mantis and a “beak” for piercing and sucking insect prey. Similar to assassin bugs (Reduviidae).
Beneficial insects
Predator and pollinator

- Hover, flower or syrphid fly (Syrphidae)
- Adult is a pollinator
- Larvae (below) are aphidophagous (eats aphids)

Toxomerus marginatus adult male
Beneficial “insects”

- Spiders
Beneficial insects?

- Damselflies
- Dragonflies
Predators follow their prey into crops

Aphid population over time (Sask)

- Total aphids

Predators over time

- aphid mummies
- lacewings
- lady beetles
Average number per head in Melfort wheat

- **No. aphids**
- **No. lady beetles**
- **Aphidius mummies (parasitoids)**

**Sample date**: 22-Jul-15, 04-Aug-15, 11-Aug-15, 18-Aug-15

- **Soft dough: crop passed danger zone**
- **Medium milk: yield danger!**

- **ET of 15 aphids/head exceeded**
A special type of predator. Female adult finds the prey but the larva kills it!

PARASITOIDS

“A parasite that kills its host”.
Parasitic insects

- Parasitoids of crop insects are usually wasps (Hymenoptera)
- Parasitoid = “a parasite that kills its host”
- Each insect pest has its own complex of parasitoids

Aphid parasitoids can be purchased online and released into greenhouses for aphid control.
Parasitic insects

- Aphid parasitoids create dead aphid “mummies” stuck to plants
  - Brown mummies = *Aphidius* spp. parasitism
  - Black mummies = *Aphelinus* spp.

Parasitism (Powell 1982, Pike et al. 1997)
Leafhopper parasitoid

- *Epigonatopus plesius*
A native parasitic wasp *Microctonus vittatae* parasitizes both *Phyllotreta cruciferae* and *P. striolata*

*M. vittatae* parasitizes *P. cruciferae* at ≤ 5% - Wylie
A native parasitic wasp *Microctonus vittatae* parasitizes both *Phyllotreta cruciferae* and *P. striolata*. *M. vittatae* parasitizes *P. cruciferae* at $\leq 5\%$ - Wylie, $\leq 2.5\%$ in Sask (Soroka 2012).
Parasitism of a bertha armyworm by the braconid parasitic wasp *Cotesia vanessae*

**Figure 2.** Parasitism of the early cutworm by a braconid wasp. **A:** Day 1, a wasp parasitizes a cutworm larva. **B:** Day 20, wasp larvae emerging from their host for pupating, thus killing the host. **C:** Day 20 to 30, pupal masses (made of tens of wasps cocoons) around dead host. **D:** Day 30, new generation of wasps emerging as adults. (Indicated development time when reared at 20°C)
The cereal aphid Dynamic Action Threshold project

- **Conventional action threshold (CAT)**
  - The population of aphids this week that will EXCEED

- **Economic threshold**
  - And trigger an insecticide treatment

The **CAT** does not account for controlling pressure of natural enemies
...current recommendations are often to “look around for natural enemies and parasitoid mummies”...with no quantification or measure of their impact (my personal opinion)

So, the **Dynamic Action Threshold (DAT)** incorporates predators and parasitoids into the action threshold as Natural Enemy Units (NEUs)

- **The basic prediction equation**
  - Aphid population growth at $t_1 = \text{No. aphids at } t_0 - \text{predation pressure} \times \text{time}$
  - Validated with real-world survey data (newest project)
  - build it into a smartphone app to use in field surveying! (ongoing project!)
Natural Enemy Units

- What and how many natural enemies are out there?
- How many aphids do they kill per day?

\[ \text{NEU}_{\text{total}} = \sum_{i=1}^{N} n_i V_i \]

**Dynamic action threshold (DAT)** incorporates predators and parasitoids as one number of the total Natural Enemy Units (NEUs)

For example:
one C7 ladybug = 0.95 NEUs on soybean aphid
One *Aphelinus* parasitoid = 0.08 NEUs
0.95/0.08 = 11.88
So, one ladybug is worth 12 parasitoids
*(Hallett et al. 2013 Pest Manag Sci)*
**$V_i$** = Voracity of a predator

- Ie. How many aphids can one of these predators kill in one day?
- In Saskatchewan, 98% of parasitoids were *Aphidius avenaphis* (Wist, Tourgeron and Van Baaren unpublished, 2015)
- Voracity was unknown, so I fixed that (refining the equation)

- One female (60% of emerged) *A. avenaphis* kills 30 aphids per day for about four days
Insect pollinators

• Transfer pollen between flowers
  – Plants offer nectar and pollen as “rewards” to attract insect pollinators
• Essential to seed set in non-wind pollinated, obligate outcrossing crops
• Boost yield in canola, and lead to faster seed set
Butterflies

Painted lady, *Vanessa cardui*, on *Echinacea purpurea*

Painted lady larvae, on Canada thistle
Sometimes butterfly larvae are also beneficial
Butterflies (Lepidoptera: Pieridae)

Small cabbage white *Pieris rapae*, large cabbage white *P. brassicae*, yellow sulphurs *Colias spp.* etc.

But, larvae are cruciferous vegetable and canola pests...
Bees (Apidae)

Honey bee (managed pollinator), Apis mellifera, is common.

Bumble bee (native pollinator): red tailed, Bombus ternarius, is common.
Bees: leafcutters (Megachilidae)

Alfalfa leafcutter bee (managed pollinator), *Megachile rotundata*: look for “bee huts” on fields

Look for scopa (pollen basket) on abdomen and cut leaves on surrounding plants.

Similar species, the Sunflower leafcutter bee (native pollinator), *Megachile pugnata*
Beeflies (Diptera: Bombylidae)

- Occasionally found depending on the year.
- Abundant during and after a grasshopper outbreak because their larvae are grasshopper egg predators.

Blister beetles (Coleoptera: Meloidea)
Field Crop...etc. etc. (#AAFCbugbook)

Field Crop and Forage Pests and their Natural Enemies in Western Canada
IDENTIFICATION AND MANAGEMENT
FIELD GUIDE

http://publications.gc.ca/site/eng/9.629939/publication.html