Maximizing the Value of Beneficial Insects on the Farm: Predators and Parasitoids

If we look hard, we can find many different insects in most fields or habitats, but this is not necessarily a bad thing. The majority of insects that are observed in most fields are either beneficial or benign. Insects can be beneficial on farms as pollinators, eating other insects, eating weeds and weed seeds, assisting in decomposition, and improving the soil. It is a relatively small proportion of insects that can cause damage to crops. Many insects prey on crop feeding insects, while others are parasitic and feed on other insects from within. At times it may be necessary to manage crop damaging insects, but ideally it is best to do so using methods that do as little harm as possible to all the beneficial insects that are performing valuable roles on your farm. This is the basis behind the concept of integrated pest management. In this factsheet we will look at some of the most common insects that prey on or parasitize crop feeding insects, and ways we can preserve them when pest management is needed.

Predaceous Beetles

There are many species of beetles in Manitoba that prey on other insects. Some of the most important of these in regulating populations of insects that feed on crops are lady beetles, ground beetles, and rove beetles. In addition, larvae of some species of blister beetles feed on grasshopper eggs.

Lady beetles (Family: Coccinellidae)

This group of insects is sometimes known as ladybugs, although entomologists prefer the term lady beetles, as these insects are not classified as true bugs.

Diversity: There are 66 species of lady beetles in Manitoba, 162 species in Canada, and 6,000 species worldwide.

Identification. Although most can recognize adult lady beetles, many do not recognize the larvae. Larvae are alligator-like in general shape and black with white, yellow, red, or orange markings. Pupae may look wrinkled, and are often attached to plant leaves and stems. Some of the common species found in crops on the Canadian prairies include the sevenspotted lady beetle, the thirteenspotted lady beetle and the multicoloured Asian lady beetle.

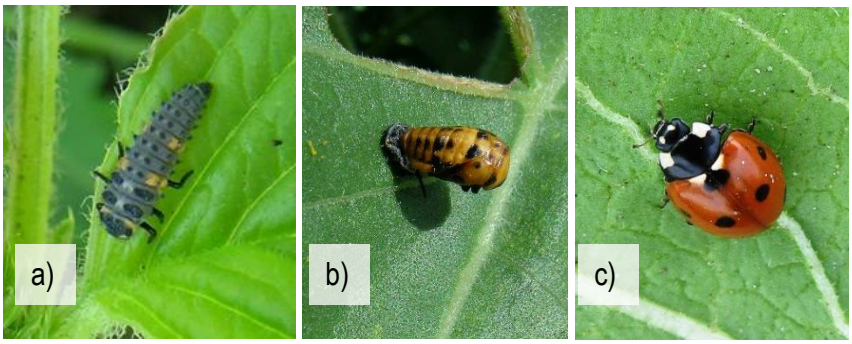

Figure 1. Larva (a), pupa (b) and adult (c) of the sevenspotted lady beetle (*Coccinella septempunctata*).

Sevenspotted Lady Beetle

Adults:

- 7 black spots on elytra; three on each elytron and one central at the base of the pronotum.
- 2 white marks behind head that look like large eyes

Larvae:

- Black with orange spots on abdominal segments 1 and 4

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Manitoba

Figure 2. Adults and larva of the multicoloured Asian lady beetle (*Harmonia axyridis*)

Multicoloured Asian Lady Beetle

Adults:

- Colour ranges from yellow to red
- Number of spots varies and can have anywhere from 0 to 19 spots
- 5 black spots forming an "M" shaped marking behind head

Larvae:

- Covered with small flexible spines
- Black with orange stripes and spots

Figure 3. Adult and larva of the thirteenspotted lady beetle (*Hippodamia tredecimpunctata*)

Thirteenspotted Lady Beetle

Adults:

- Somewhat elongated
- 13 spots on elytra; 6 spots on each and 1 central spot.

Larvae:

- Black with white markings
- Solid white stripe on 4th abdominal segment

What they eat: Aphids. If aphids are scarce, they may feed on the eggs of moths and beetles. They may also feed on thrips, mites and other small insects, and some species may additionally feed on pollen and nectar.

How much they eat: A study in Manitoba on lady beetles feeding on different species of aphids on cereal crops found that the number of aphids consumed depended on the species of lady beetle and the species of aphid being consumed. Adults of the thirteenspotted lady beetle, one of the more common species in Manitoba, each consumed between 110 and 160 aphids on average in 24 hours, depending on the species of aphid they were feeding on.[1] Studies from Ontario measuring soybean aphid consumption by lady beetles found that at high soybean aphid densities adult females of the sevenspotted lady beetle ate about 115 aphids in 24 hours, adult males ate about 80 in 24 hours, and third instar larvae ate about 105 in 24 hours.[2]

How they find their prey: Research in Iowa found that soybean plants containing soybean aphids released methyl salicylate, which was highly attractive to the sevenspotted lady beetle.[3]

Ground Beetles (Family: Carabidae)

Diversity: 376 species in Manitoba, 983 species in Canada, and about 34,000 species worldwide. To put this in perspective, there are about 10, 700 species of birds worldwide; so there are over three times as many species of ground beetles as birds worldwide.

Most species of ground beetles are nocturnal (active at night), however most species in the genus *Bembidion* are diurnal (active during the day). *Bembidion* is the largest genus of ground beetles; there are 71 species in Manitoba

and 176 species in Canada. The tiny *Bembidion quadrimaculatum* can often be seen running around on the soil during the day.

Pterostichus melanarius is native to Europe and was introduced into North America in the 1920s.

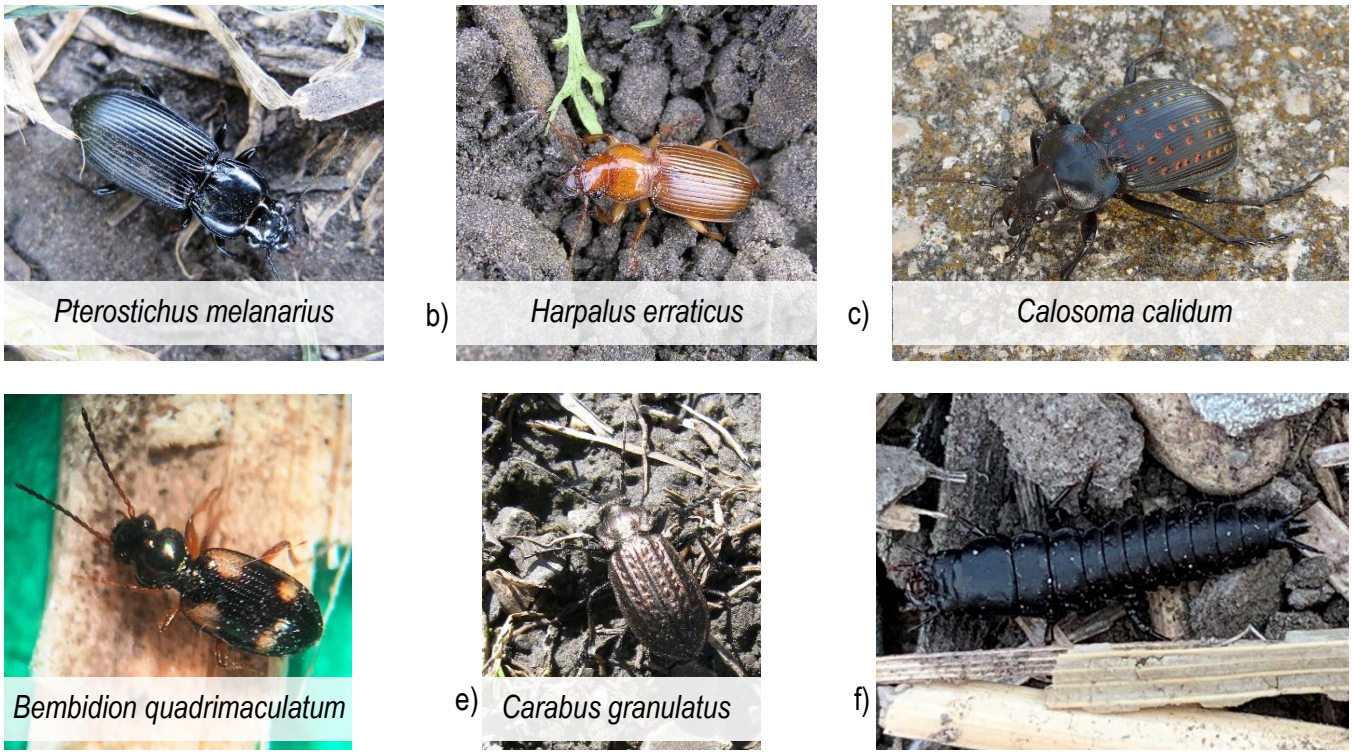


Figure 4. Ground beetle adults (a-e) and ground beetle larva (f)

Identification tips. Head at eyes narrower than section behind head. Elytra (the hard forewings of beetles) may have striations or pits. Run rapidly when disturbed. Ground beetles vary in size including small beetles such as *Bembidion quadrimaculatum*, which is roughly 3 mm long, and larger beetles such as the 20-25 mm long *Calosoma calidum.*

What they eat: Larvae of cutworms and diamondback moth; Colorado potato beetle and root maggot eggs, larvae, and pupae; aphids; eggs of grasshoppers and pea leaf weevil. A species called *Lebia atriventris* has been observed feeding on larvae of sunflower beetles in Manitoba. A study in Saskatchewan found 14 species of ground beetles fed on larvae of wheat midge.[4]

How much they eat: Larvae and adults of several species of ground beetles have been shown to eat many times their own weight in prey if given the opportunity. Adult *Bembidion quadrimaculatum* can eat up to 25 onion maggot eggs per day each.

Other potential Benefits: Some species of ground beetles feed on weed seeds and could have some potential for biological weed control, particularly certain species of *Harpalus* and *Amara.* In laboratory studies, five *Harpalus pensylvanicus* consumed all 250 redroot pigweed seeds available in a 40 hour period.

Rove Beetles (Family: Staphylinidae)

Figure 5. Adult rove beetle

Diversity: 390 species in Manitoba, 1774 species in Canada, and about 64,000 species worldwide.

Identification tips: Adult rove beetles are slender. They have short wings; 3-6 segments of the abdomen may not be covered by the wings. They often run fast, sometimes with the tip of their abdomen bent upward.

What they eat: Most adults and larvae are predaceous on insects, and a few are parasitic. Some species eat root maggot eggs and larvae.

How much: *Aleochara* adults may consume up to 5 root maggot larvae per day – a pair may destroy 1200 eggs and 130 larvae, and parasitize several hundred pupae during their lifetime.

Predaceous Flies

There are many groups of flies that are predators of other insects. For some groups, such as hover flies and stiletto flies, it is just the larvae that are predaceous, while in other groups, such as robber flies, both the adults and larvae are predaceous. Here we feature three groups of predaceous flies: hover flies, robber flies and stiletto flies. Other predaceous species of flies include bee flies (Bombyliidae), and long-legged flies (Dolichopodidae).

Hover Flies (Family: Syrphidae)

Diversity: About 539 species in Canada and over 6,000 species worldwide.

a) 

b) 

c) 

Figure 6. Hover fly larva (a) and adults (b, c)

Identification tips: Adults of many species of hover flies resemble bees or wasps, but only have 1 pair of wings. The abdomen may have black and yellow stripes. A wasp or bee's antennae are more noticeable than hover flies, and wasps have narrower waists than hover flies. Hover flies are also much better at hovering than bees and wasps, and adults often hover over flowers. Larvae of most species of hover flies are slug-like, legless, and taper towards the head. They are commonly brown, greenish, pink, or whitish.

What they eat: Adults often feed on nectar and/or pollen. They can be valuable pollinators, and are often considered the second-most important group of pollinators after bees. Larvae of most species are predators. Many species are important predators of aphids, and some may also feed on thrips, scale insects or small caterpillars.

How much: A single larva may consume up to 400 aphids during development, depending on species of hover fly and aphid.

Robber Flies (Family: Asilidae)

Diversity: 222 species in Canada and about 7,500 species worldwide.

Figure 7. Robber fly adults

Identification tips: Adult robber flies have elongate bodies with tapered abdomens and long legs used for grabbing prey. The top of the head has a divot between the eyes, and the face has a bearded appearance. They are often brown, gray, or black but a few species mimic bees. Depending on the species, the head and abdomen may be bristled.

What they eat: Both the adults and larvae of robber flies are predaceous. The larvae live in the soil where they feed on insect eggs, larvae such as wireworms and root maggots, and other soft-bodied soil-dwelling creatures. The adults are generalist predators and have been recorded feeding on a diverse range of insects including grasshoppers, leafhoppers, beetles, wasps, aphids, midges, and other flies.

Adult robber flies perch, generally in open sunny areas, to locate prey. Once located, the fly seizes its victim mid-flight and injects them with saliva that immobilizes and liquifies the tissues. The fly then has access to a liquid meal which is generally consumed upon returning to its perch.

How much they eat: Robber flies can reduce grasshopper populations by 11% to 15% under some conditions. A study in Nebraska on the robber fly *Proctacanthus milbertii* estimated they may take from 0.5% to 2% of the adult grasshoppers per day.

Stiletto flies (Family: Therevidae)

Diversity: 50 species in Canada, and about 1,600 species worldwide.

a) 

b) 

Figure 8. Stiletto fly larva (a) and adult (b)

Identification tips: Do not confuse these with wireworms. Therevid larvae will thrash around a lot when disturbed, something wireworms will not do. Also notice the lack of legs on the larva of the stiletto fly; wireworms have 3 sets of small legs near the front.

What they eat: Larvae of this family of flies live in the soil or decaying materials and are voracious predators of earthworms and many insects, including wireworms, cutworms, and grasshopper eggs.

True bugs (suborder: Heteroptera)

There is a suborder of insects referred to as true bugs, where the basal part of the forewings are leathery, and the tips are membranous. Some types of true bugs prey only on other insects, some will feed on both other insects and plant sap, and some only on plant sap. Families of true bugs that feed primarily on other insects include minute pirate bugs, damsel bugs, assassin bugs, and ambush bugs. Although many species of stink bugs feed on plant sap, there are some species that are predaceous.

Minute Pirate Bugs (Family: Anthocoridae)

Diversity: 41 species in Canada and 500 species worldwide.

Identification tips: Adults are oval, black with white markings; 3-5mm. Nymphs orange to brown.

What they eat: Insect eggs, small caterpillars, thrips, mites, and aphids. Some species may be important predators of soybean aphids and larvae of European corn borer. After impaling prey with their beak, they inject an anesthetizing fluid to paralyze the prey, which is then sucked dry. May also feed on pollen and plant juices, enabling them to survive in the absence of prey.

Figure 9. Minute pirate bug adult

How much they eat: Minute pirate bugs may kill more insects than they consume. In both adults and nymphs, an individual can consume over 30 spider mites per day.

Damsel Bugs (Family: Nabidae)

Diversity: 22 species in Canada and 400 species worldwide.

Identification tips: Long and slender. Enlarged front legs.

What they eat: Aphids, moth eggs, small caterpillars (including European corn borer and corn earworm), leafhoppers, mites, lygus bug nymphs. Damsel bugs can be important predators of diamondback moth. In a laboratory study an average of 131 eggs or 95 larvae of diamondback moth were killed by a single of female adult in 24 hours at 24 °C.[5] Note- the toxin used by damsel bugs to subdue their prey will kill, even if the prey is not eaten.

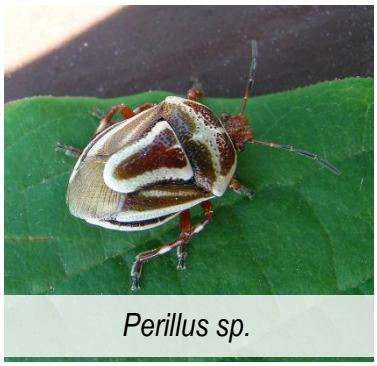
Figure 10. Damsel bug adult

Predatory Stink Bugs (Pentatomidae: subfamily Asopinae)

Although many species of stink bugs feed on plant sap, there is a subfamily of stink bugs called Asopinae that are predaceous. Prey is primarily slow-moving soft-bodied insects, especially larvae. Some of these predatory stink bugs can be of importance agriculturally. For example, a species known as the spined soldier bug (*Podisus maculiventris*) is known to prey on larvae of diamondback moth, European corn borer, imported cabbageworm, and

Colorado potato beetle. The twospotted stink bug (*Perillus bioculatus*) feeds on all stages of the Colorado potato beetle, and larvae of sunflower beetles.

Apateticus sp.



Perillus sp.

Figure 11. Predacious stink bugs

Green Lacewings (Order Neuroptera, Family Chrysopidae)

Diversity: 26 species in Canada and 1,200 species worldwide.

Figure 12. Adult green lacewing

Figure 13. Lacewing larva eating Lygus bug

Identification: Adults are green, with wing veins that look like netting, and have gold eyes. Larvae are alligator-like in general shape (similar to lady beetle larvae), cream coloured with brown markings and sickle-shaped mandibles. They are sometimes referred to as aphidlions. Instead of chewing their prey like lady beetle larvae would, lacewing larvae inserts their mandibles into the body of the prey and suck fluids through a channel or groove on the inside of the mandible. Larvae have long bristles coming out from the sides. These bristles will collect debris and food remains, including the skins of aphids, that may provide camouflage. Eggs are laid on stalks.

What they eat: Aphids, thrips, and mites. They also eat eggs of many insects (including leafhoppers and Colorado potato beetle), small caterpillars and beetle larvae (including larvae of Colorado potato beetles). They will eat diamondback moth eggs, larvae and cocoons.

How Much: Developing lacewing larvae eat from 100 to 600 aphids.

Spiders (Class: Arachnida; Order: Araneida)

Diversity: There are at least 483 species of spiders in Manitoba. There are 767 recorded species of spiders in the Prairie Provinces. Forty-seven species of spiders were caught in a study of the diversity and abundance of spiders in a wheat field and its grassy borders in Saskatchewan.

Figure 14. Crab spider (light yellow on flower) eating fly.

Figure 15. Jumping spider

What they eat: Generalist predators. Prey ranges from mites and aphids to moths, flies, and beetles.

Parasitoids of Potential Pest Insects

Insects that parasitize and kill other insects are called parasitoids. In their immature stages these parasitoids live in or on the body of another insect (the host), but they are free-living as adults. Many of the parasitoids of insects in Manitoba are either wasps or flies. Parasitic wasps do have what looks like a stinger, but they use this to lay eggs in the insects that they are parasitizing, and not to sting people.

Parasitic wasps

Although extremely diverse and often common, parasitic wasps are often hard to identify, and abundance hard to appreciate when monitoring crops. Thus, it is difficult to factor them into pest management decisions. However, aside from the ability to identify the adult stages of these parasitoids, there are a few ways that evidence of parasitism can be seen when scouting crops.

Ichneumonid wasps (Family: Ichneumonidae)

Diversity: 672 species in Manitoba, 3,037 species in Canada, and 25,000 species worldwide. This is one of the largest families of insects.

Identification: Slender, antennae usually at least half as long as body. The abdomen is usually noticeably longer than the thorax. Vary greatly in size and colour. Some species have very long ovipositors (used to lay eggs), enabling them to parasitize concealed hosts. The adult females need a source of nectar for their eggs to mature.

Figure 16. *Banchus flavescens*

Braconid wasps (Family: Braconidae)

Diversity: 272 species in Manitoba, 1,165 species in Canada, and 17,000 species worldwide. It is estimated that there are many undescribed or unrecorded species of ichneumonid and braconid wasps in Canada.

Identification: Usually smaller than ichneumonid wasps and rarely exceed 15 mm in length. Most are brownish or black, and not brightly coloured. Many species emerge from the host to pupate in silken cocoons.

Figure 17. *Cotesia* (Braconidae) larvae emerging from armyworm

Figure 18. Pupal cases of *Cotesia*

Figure 19. Adult *Cotesia* from armyworm

Often *Cotesia* wasps will lay many eggs (20 to 60) into a caterpillar. About 2 or 3 weeks after eggs were laid into the caterpillar, the wasp larvae emerge from the caterpillar, which dies when the wasp larvae emerge. Emergence of the multiple larvae happens over quite a short period of time. Then they spin their cocoons on or near the caterpillar, forming a cluster of pupal cases, which can be quite visible at the top of plants. People often mistake these for eggs. Clusters of pupal cases of *Cotesia* can sometimes be seen on the heads of cereal crops where armyworms had been present.

Mummies in your crops? A subfamily of Braconidae called Aphidiinae are commonly referred to as aphid mummy wasps. These are tiny, usually less than 3 mm. Adult females lay their eggs in aphids. The larvae hatch and develop inside the aphids, eventually killing them. Aphid "mummies" are swollen, dead aphids that have been tanned and hardened due to aphid mummy wasps. Note the holes in the aphid mummies in Figure 21, where the parasites emerged from some of these aphid mummies.

One way the activity of parasitoids can easily be recognized is through the appearance of aphid mummies.

Figure 20. *Aphidius ervi*, a species of aphid mummy wasp. Photo by Tyler Wist, AAFC Saskatoon.

Figure 21. Aphid mummies

Other families of parasitic wasps

There are several other families of parasitic wasps that include species that can be important in regulating populations of crop feeding insects in the Canadian prairie provinces.

Diversity: Pteromalidae (58 species in Manitoba, 293 species recorded in Canada, and 3,500 species worldwide).

Eulophidae (87 species in Manitoba, 374 species in Canada, and 4,300 species worldwide).

Encyrtidae (14 species in Manitoba, 100 species in Canada, and 3,700 species worldwide).

Many species of Encyrtids are polyembryonic, where 10 to over 1,000 young can develop from a single egg.

Figure 22. *Tetrastichus julis* (top and left) (Eulophidae)

Table 1. Wasp Parasitoids Important in Managing Potential Crop Pests in Manitoba.

Parasitoids	Major crop feeding insect host or prey
Banchus flavescens (Ichneumonidae)	Bertha armyworm
Diadegma insulare (Ichneumonidae)	Diamondback moth
Glypta prognatha (Ichneumonidae)	Banded sunflower moth
Microplitis plutellae (Braconidae)	Diamondback moth
Cotesia sp. (Braconidae)	Armyworms, cutworms, diamondback moth
Aphidius ervi (Braconidae: Subfamily Aphidiinae)	Aphids
Aphidius smithi (Braconidae: Subfamily Aphidiinae)	Aphids
Macroglenes penetrans (Pteromalidae)	Wheat midge
Tetrastichus julis (Eulophidae)	Cereal leaf beetle
Pediobius eubius (Eulophidae)	Hessian fly
Platygaster hiemalis (Platygasteridae)	Hessian fly
Copidosoma bakeri (Encyrtidae)	Cutworms

Effectiveness:

- Parasitism of bertha armyworm by *Banchus flavescens* may exceeds 40% in some years. [6]
- Over a 10 year period (1961-70) in Saskatchewan, 35 to 81% of first generation larvae of the diamondback moth were parasitized by *Diadegma insularis* and *Microplitis plutellae*, averaging 68%.[7]

- A study in Saskatchewan found that on average 33% of wheat midge populations were parasitized by *Macroglenes penetrans.*

Releases of *Tetrastichus julis* have been made in the Canadian prairies for the management of cereal leaf beetles.

Over 104,000 adult *Aphidius smithi* were released in Manitoba between 1983 and 1987 to help manage aphids. [8]

Parasitic Flies

Tachinid Flies (Family: Tachinidae)

Diversity: 736 species in Canada and 10,000 species worldwide.

Identification: Adults of some species may resemble houseflies, but have very stout bristles at the tip of the abdomen. Larvae are legless and feed and develop inside the prey host. Tachinid eggs can sometimes be seen on caterpillars.

What they eat: Larvae parasitize other arthropods. Adults feed on nectar.

How Much: The tachinid fly *Athrycia cinereа* may kill over 20% of bertha armyworm.[6]

Figure 23. *Athrycia cinerea*

Figure 24. Tachinid egg on armyworm.

Table 2. Fly Parasitoids Important in Managing Potential Crop Pests in Manitoba.

Parasitoids	Major crop feeding insect host or prey
Athrycia cinerea (Tachinidae - Tachinid flies)	Bertha armyworm, etc.
Villa spp. (Bombyliidae – Bee flies)	Cutworms
Blaesoxipha atlanis (Sarcophagidae – Flesh flies)	Grasshoppers

Conserving Predators and Parasites

There is economic value for farmers to having high populations of predators, parasitoids, and pollinators in or near their fields. So, if crop feeding insects do get to levels that may be economical, decisions and management strategies which preserve as many of these beneficial insects as possible may ultimately be the most economical strategy. While killing all insects in the field may solve a current problem, it can make the field quite vulnerable to crop feeding insects that may reenter the field, particularly those that can be moved in large numbers or can produce multiple generations in a year. It may also make crops in the area more susceptible in future years. The

aim of the following tips is to help you maximize the value from beneficial insects in and around your fields, while still managing insects that get to levels where they are a potential threat to the crop.

1. **Use economic thresholds** when these are available. Applying insecticides when crop feeding insects are not at high levels can cause more harm than good. If beneficial insect populations are keeping crop feeding insects below economic levels, destroying the beneficial insects can potentially result in conditions allowing some crop feeding insects to reach pest levels.
2. **Selective insecticides:** If insect levels surpass the economic threshold and use of an insecticide is desired, use a selective insecticide if practical, which targets a specific group of insects and has little or no harm to natural enemies.
3. **Selective application patterns**: Spray only patches, field edges or in strips where practical. Some insects, such as cutworms, may occur at high levels only in distinct patches, and whole fields may not need to be treated. Other insects may be more abundant at field edges.
4. **Insect-resistant crops.** Crops that have some resistance or tolerance to crop feeding insects, such as midge tolerant wheat or *Bt* corn, can be used when populations of crop feeding insects are a high risk. These crops target specific crop feeding insects, and will have little or no harm to natural enemies of insects.
5. **Crop rotation** can prevent some insects that potentially can reach pest levels from achieving levels that cause economic damage.
6. **Providing favorable habitat** for beneficial insects can help maintain consistent populations. Adult hover flies and parasitic wasps need pollen and nectar for longevity and reproductive success. A diversity of flowering plants, both in species diversity and when they flower, is good. For example, adults of some parasitic wasps will visit flowering plants in many families to obtain nectar and pollen. However, a considerable number of species with short mouth parts may be restricted to plants of a few or one family, such as umbelliferous plants that have exposed nectaries. Minimum or zero tillage may increase populations of some predaceous insects.

Summary

We have seen that there are many insects that can help regulate levels of crop feeding insects. Healthy populations of insects like lady beetles, ground beetles, lacewings, damsel bugs, and many parasitoids can often keep crop feeding insects at insignificant levels. There are things we can do to preserve and enhance the abundance of these beneficial insects. With good management decisions and the proper environment, this free biocontrol can help maximize the value of your crop.

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